Evaluation of bone mineral density score in patients undergoing Total knee replacement

A THESIS SUBMITTED TO THE BABA FARID UNIVERSITY OF HEALTH SCIENCES, FARIDKOT (PUNJAB)

FOR THE AWARD OF DEGREE OF

MASTER OF SURGERY

IN

ORTHOPAEDICS

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Dedicated to

my

Family

&

Teachers

ACKNOWLEDGEMENT

As I sit down to pen the conclusion to this thesis, memories flash in my mind and fill my heart with immense gratitude towards all those who, with their unending support and encouragement, have contributed in its successful completion and made this an unforgettable experience for me.

At the onset of such major task, difficulties seemed insurmountable. I am highly grateful to the ***Almighty*** *for enlightening the path and being the guiding force through all ups and downs in this journey.*

I would like to express the deepest appreciation to my supervisor and mentor, ***Dr. Pankaj Mahindra*** *(Associate Professor, Department of Orthopaedics, DMC&H, Ludhiana), who has the attitude and the substance of a genius: he continually and convincingly conveyed a spirit of adventure in research and an excitement in regard to teaching. I take great pride in expressing my gratitude to him. He has always been an epitome of excellence for me. This thesis would have remained a dream had it not been for the scholarly guidance and constant encouragement of my cosupervisor,* ***Dr. RajnishGarg*** *(Professor and Head, Department of Orthopedics, DMC&H, Ludhiana) and* ***Dr. Parminder Singh*** *(Professor and Head, Department of Endocrinology) With great reverence and profound pleasure, I acknowledge his indelible help and fervent interest at all stages of this project, which helped in making it a success.*

I convey my sincerest thanks to my teachers ***Dr.Harpal Singh Selhi, Dr.Deepak Jain****,* ***Dr. ShekharSinghal*** *and* ***Dr. Raskesh Malhotra*** *for their constant encouragement and kind support.*

I thank my colleagues, seniors and juniors at DMC&H, Ludhiana for being generous companions. They have been an invaluable support day in and day out.

Words fail miserably as I express my gratitude to my parents and parent in laws for all their love and affection, selflessness, numerous sacrifices,

unfaltering attention to my needs and unparalleled determination in striving to make me what I am today.

*I owe a big thanks to my better half , **Mr. Gurtej Singh** who stood by me at every step of my life and whose incessant support and encouragement, patience and unwavering faith have helped me sail through testing waters undeterred.*

I bow my head in sincerely acknowledging all my patients who consented to become the subjects of this thesis. Without their cooperation, this study would not have seen the light of the day.

*A special thanks to **Mrs. Niharika** & her team at Research & Development Centre, DMC&H, Ludhiana for their sincere efforts in a fine reproduction of this work.*

Dr. Aamna Athwal....

ABBREVIATIONS

BMD	bone mineral density
DXA	dual energy X-ray absorptiometry
ISCD	International Society for Clinical Densitometry
JSN	joint space narrowing
KOOS	Knee Injury and Osteoarthritis Outcome Score
KSS	Knee Society Clinical Rating System
OA	Osteoarthritis
OKS	Oxford Knee Score
OP	osteoporosis
PROMs	patient-reported outcome measures
RA	Rheumatoid Arthritis
RCTs	randomized controlled trials
RHOA	radiographic hip OA
THA	total hip arthroplasty
TKA	Total knee arthroplasty
TKR	Total knee replacement
VAS	Visual Analogue Scale
aBMD	areal BMD

ABSTRACT

Background

Total knee replacement (TKR) is an effective treatment for advanced knee arthritis providing significant pain relief and improved joint function. Pain and length of recovery are the two main concerns in patients before going for total knee arthroplasty (TKA). However its association with bone mineral density before and after the surgery has been studied less in the past and still remains an enigma.

Objectives

To evaluate bone mineral density (BMD) changes of axial bones after total knee replacement (TKR) due to severe osteoarthritis (OA) of the knee joint in Indian population.

Methods

The present study was a prospective Interventional Cohort Study conducted at the Department of Orthopaedics, Dayanand Medical College, Ludhiana. The study included 43 admitted patients for elective total knee replacements who were analyzed under a period of 6 months to determine the association of BMD in patients undergoing TKR in the 6 months follow up.

After TKR, the patients were again assessed for BMD and range of motion at 6 months follow up. The comparison of BMD was made between the pre-operative and post-operative 6 months values.

Results

The study population was elderly with patients in their sixties or more. Majority of them were females (72.1%) who were mainly housewives. DEXA scan showed that 41.9% patients had normal BMD, 39.5% had osteopenia and 18.6% had osteoporosis. Post-TKR it was seen that the

patients showed a significant improvement in the femur BMD score from 0.90 ± 0.22 to 0.94 ± 0.18 (p value = 0.047) with a femur T-score improvement from (-0.88 ± 1.26) to -0.65 ± 1.30 post operatively (p value = 0.027). Overall the spine BMD score did not show a significant improvement (1.60 ± 3.07 in pre-op vs 1.13 ± 0.18 at 6 months respectively) (p value = 0.327).

Conclusion

Our study showed promising results of TKR in terms of significant improvement in the bilateral range of motion and the femur BMD score which shows a better hope to patients needing TKR. Though there was a significant improvement in the BMD of spine post surgery but the spine BMD remained comparable to the per-op findings. In view of this, future studies with long-lasting and more frequent follow-ups are needed to understand the impact of post-TKR changes in BMD.

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INTRODUCTION

Total knee arthroplasty (TKA) is one of the primary procedures for knee replacement which have an established arthritis arising out of primary Osteoarthritis (OA), Rheumatoid Arthritis (RA), Juvenile Rheumatoid Arthritis, secondary osteoarthritis due to Post-Traumatic, haemophilia, crystal arthropathy or other types of inflammatory arthritis.[1,2] Amongst the various causes, Osteoarthritis is considered to be the most prevalent chronic joint disease of the knee.[3]

The incidence as well as prevalence of osteoarthritis is on the rising trend because of the ageing population and the rising epidemic of obesity and pre-obesity. In one of the latest Indian studies published in 2020, prevalence of OA was reported to be 28.7% which varied slightly in the individual states – Agra (35.5%), Bangalore (26.6%), Kolkata (33.7%), Dehradun (27.2%), and Pune (21.7%). It was seen that OA prevalence was more in participants who used western toilet (42.1%), in sedentary people (82.9%), in females and in obese.[4]

Osteoarthrosis (OA) is a cartilage disease with multifactorial etiologies which include interplay between systemic and local factors. Sports participation, injury to the joint, obesity, and genetic susceptibility predispose adolescent athletes to the development of premature osteoarthritis.[5]Old age, female gender, overweight and obesity, knee injury, repetitive use of joints, bone density, muscle weakness, and joint laxity all play roles in the development of joint OA.[6]

Amongst the various factors, the association between OA and bone density (low as seen in Osteoporosis) has been complex and of an inverse type. Osteoporosis and osteoarthritis are common diseases in women over the age of 65 and recent increase of aging population has increased the number of patients as well as the surgical management cases of both diseases. Because the main risk factors of Osteoporosis are aging and low body weight while those main risk factors of knee osteoarthritis are aging and obesity, these diseases have been considered as having inverse relationship.

In general, OA could possibly be used as a negative indicator for selecting patients at risk for osteoporosis. In particular, in the case of patients with severe knee OA, gait disturbance due to pain and reduced activity in the living environment and poor exercise capacity make the bone mineral density of the hip equal or decreased.[7] However, the Chingford study reports that increased BMD, when associated with radiographically diagnosed OA, does not reduce the risk of osteoporotic fractures.[8] Large epidemiologic studies, focused on cross-sectional data, have reported higher levels of BMD in subjects with knee osteoarthritis.[9,10,11] Patients with specific radiographically diagnosed changes to their knee OA have greater hip, total-body, and lumbar spine BMDs compared with those showing normal knee radiographs.[12]

Women who develop incident knee OA, defined by osteophytes, seem to have had significantly higher BMD even 4 yr previously. Thus, decreasing hip BMD might be associated with the progression of knee OA.[13] In the Framingham study, a high BMD was associated with an increased risk of incident knee OA, but it decreased the risk of progression of knee OA. If advanced knee OA has been present for some time, the resulting immobility is likely to affect bone density.[14]

Though the link between low BMD leading to grater fracture risk is well established in literature, what is not fully understood is the impact of TKR on BMD levels. Literature is sparse which compared BMD in Normal, Osteoporotic and Osteopenic patients who underwent TKR. The studies about change of axial BMD in patient who underwent total knee anthroplasty due to severe OA are few with the absence of a consistent consensus.

Poor understanding of the natural history of OA contributes to the slow development of intervention strategies such as the use of bisphosphonates and weight bearing exercises, that could modify the incidence and progression of the disease and thus help patients to avoid OA-related functional impairments.[15] To improve

our knowledge of the natural history of OA and its bone-remodeling effects, we need to focus on the bone mineral density analyses (DEXA scan) of hips and knee, which are often affected in patients with treated knee OA (TKR).

So we conducted this study with an aim to measure the BMD changes of HIP and SPINE in patients receiving total knee replacement due to severe degenerative OA and thereby identify the clinical correlation factors such as postoperative bisphosphonate medication, bilateral operation, the operations obesity status, preoperative knee function score or preoperative diagnosis of Osteoporosis in determining the follow up outcomes of the patients.

AIMS AND OBJECTIVES

- To understand the impact of total knee replacements/revisions or arthroplasties on BMD levels. Based on the available evidence, total knee replacements/revisions and arthroplasties increase BMD and thus decrease fracture risk. This review also addressed the possible implications of this research and possible options to reduce this risk.
- There are few reports on bone mineral density (BMD) changes of axial bones after total knee replacement (TKR) due to severe osteoarthritis (OA) of the knee joint and its results are controversial and not much pronounced in Indian population.
- To evaluate bone mineral density (BMD) changes of axial bones after total knee replacement (TKR) due to severe osteoarthritis (OA) of the knee joint in Indian population.

REVIEW OF LITERATURE

Two of the predominant pathological disorders that affect bone mineral density (BMD) are osteoarthritis (OA) and osteoporosis (OP). Due to the destructive nature of OA on the joints and the resulting loss of mobility and function, surgery is a primary option, and as such, OA accounts for between 80 and 90% of all total knee replacement (TKR/arthroplasty) procedures.[16]

The relationship between OA and OP is complex and has been reported to be an inverse one, with OA being reported to increase BMD, and thus, it might be assumed to increase fracture protection. 7With such a high percentage of cases of TKR due to OA, it could be concluded that this protective effect would reduce fracture risk in TKR patients due to having higher BMD, but increased fracture rates have also been reported in OA.

This literature review assessed the links between BMD, OA, and TKR with an aim to clarify the link between them so that appropriate management of post-TKR patients may be done with varying BMD.

For a deeper understanding it is essential to understand the kinetics of knee joint and how it gets affected in OA.

Kinetics of Knee Joint

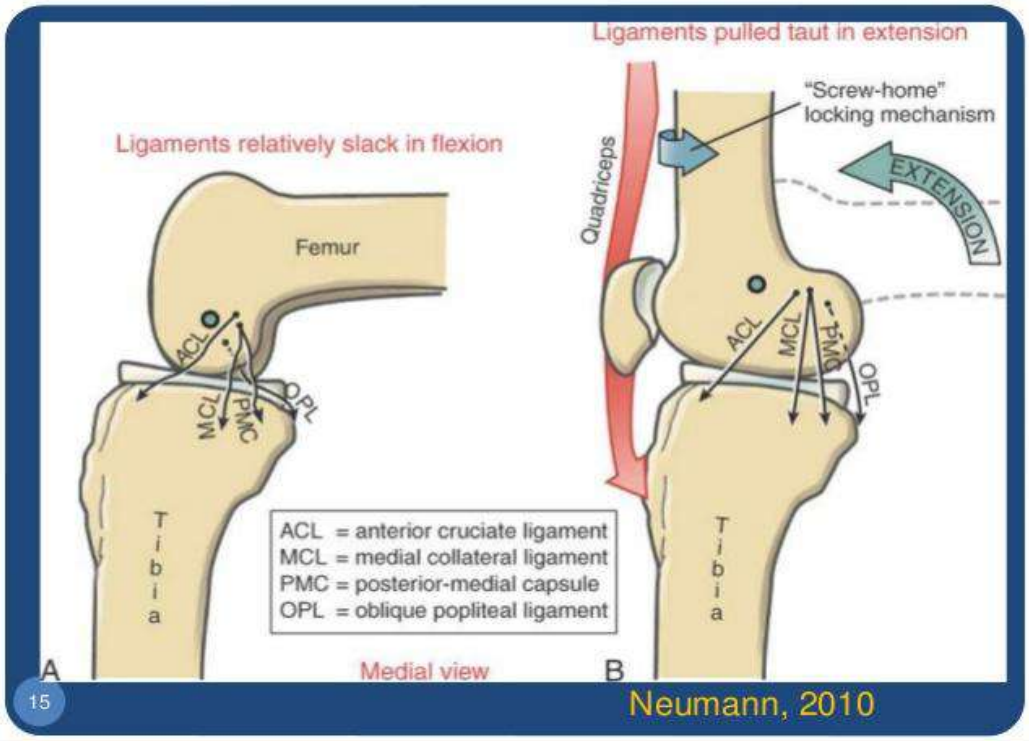
There are two joints at the knee- tibiofemoral and patellofemoral. The tibiofemoral joint experiences forces between the femur and tibia and operates as a modified hinge joint; whereas, the patellofemoral saddle joint operates primarily as an extensor mechanism to increase quadriceps leverage. Kinematics describes human movement in three-planes and three-axes.[17]

Cardinal planes and axis of movement		
Plane	**Axis**	**Description**
Sagittal	Coronal (X)	Lateral perspective—medial/ lateral sections
Transverse	Vertical (Y)	Axial perspective—superior/inferior sections
Coronal	Sagittal (Z)	Frontal perspective—anterior/posterior sections

The relationship between a plane and its axis can be easily seen as plane/axis in the context of a 3D coordinate system. It is imperative to understand how bones move in relation to joints (Osteokinematics) and the manner in which joint surfaces move in relation to adjoining joint- surfaces (Arthrokinematics) to understand the complexity of knee function. Osteokinematics pertains to the voluntary bone movements at synovial joints relative the joints' central axis of rotation. The tibiofemoral joint is considered triaxial, moving in three planes around three axes, giving it three degrees of freedom – flexion/extension, adduction/abduction and internal/external rotation.[17]

Arthrokinematics is concerned with how joint surfaces move in relation to each-other – primarily involuntary roll, glide and spin characteristics that ensure stability and joint congruence during movement. Tibiofemoral roll & glide are necessary for effective tibiofemoral flexion and extension – without them the larger femur would simply roll off the tibia and/or vice-versa. Patellofemoral movements are primarily arthrokinematic because it is a synovial glide joint. [17]

Figure: 1-Biomechanics of the knee joint.[18]



Factors Affecting Degeneration of Knee Joint

OA has multifactorial etiologies, which occurs due to interplay between systemic and local factors. Osteoarthritis affects all ages. Sports participation, injury to the joint, obesity, and genetic susceptibility predispose adolescent athletes to the development of premature osteoarthritis. Previous knee trauma increases the risk of knee OA 3.86 times.5 Old age, female gender, overweight and obesity, knee injury, repetitive use of joints, bone density, muscle weakness, and joint laxity all play roles in the development of joint OA. Mechanical forces exerted on the joints are a significant cause of OA and one of the most modifiable risk factors as determined by body BMI. Female sex, lower educational levels, obesity, and poor muscular strength are associated with symptomatic disease and subsequent disability.[19]

Frequent squatting predisposes people to development of knee OA. Prolonged squatting is a strong risk factor for tibiofemoral

knee OA among elderly.[20] Occupation involving squatting or kneeling more than two hours daily were associated with two-fold significantly increased risk of moderate to severe radiographic knee OA.

Obesity alone or in patients with metabolic syndrome increases the risk of radiographic knee OA but has a lesser effect progression of knee OA.[21,22] Relationship between BMI and OA of the knee is mainly linear, and duration of increased joint loading or gaining weight is also significant.[22]

It has been postulated that the leptin system could be a link between metabolic abnormalities in obesity and increased risk of OA. Meniscal surgery increases the risk of future knee OA by 2.6 times.[23] Inflammatory process has been shown to be associated with OA. Inflammation may have a contributive role in the development and progression of OA. The median value of CRP is significantly associated with functional disability, joint tenderness, pain, fatigue, global severity, and depression in OA. Mean CRP level in OA is greater than healthy individuals. [24]

Table 1: Risk factors of knee osteoarthritis[25]

• Age • Female gender • Obesity • Muscle weakness	• Repetitive knee trauma • Kneeling • Joint laxity	• Squatting • Miniscal injuries, Trauma • Genetic susceptibility • Mechanical forces

Among all the risk factors, Obesity has been found to be one major factor affecting the outcomes of TKR because of the

increased pressure it creates on the knee joint and the associated co-comorbidities alongwith as seen in the patients.

TKR is the gold standard treatment for OA.

Evolution of TKR

One of the important milestones in the history of orthopedic surgery is the invention of total knee arthroplasty (TKA). In the early 1970s, in both the United States as well as other countries, the development of TKA initiated when tibiofemoral condylar replacements sprouted independently. A large number of surgeons as well as engineers was included in this process. Presently, it has is a multibillion dollar industry; annually millions of knees are implanted globally[26]

Knee joint is one of the most commonly affected joint by osteoarthritis. The concept of improving knee joint function by modification in the articular surfaces has received attention since the 19th century. Total knee replacement (TKR) is an effective surgical intervention for patients with knee osteoarthritis. TKR has an established place in the treatment of knee osteoarthritis and is considered to be an effective intervention. TKRs are reported to relieve pain and improve mobility, the best published results reporting a “good” or “excellent” outcome in approximately 90% of patients. [27]

India is a country of 1.2 billion people with significant knee and hip arthritis population. According to Frost and Sullivan research, the arthroplasty market was expected to grow at a compound annual growth rate of 26.7% during 2010-2017. [28] According to this survey, almost 70,000 joint replacement surgeries were performed in India in the year 2011. [29]

In 2010, 76,759 hip replacements and 81,979 knee replacements were performed in the NHS, and it is predicted that due to increases in obesity and an aging community, these figures will rise considerably in coming years[30]Approximately 30,000 TKRs

are carried out in England and Wales each year, [31] and it is estimated that there is likely to be a 30% increase in the need for all TKRs in the next 3 decades, due to changing demography. [32]

TKR is generally undertaken to reduce pain and improve function for people with advanced OA. Pain and disability are inextricably linked in OA, as the pain is largely activity-related. [33] TKR for the management of OA is considered to be one of the most cost-effective operations performed, with well-documented improvements in patient benefits, reducing pain, and improving physical function. The goals of TKA include reducing pain, returning to activities of daily living, restoring mechanical alignment, preserving the joint line, balancing the ligaments, and restoring a normal Q angle. [34]

However, not all prognoses of patients with TKRs are positive. Some patients with TKR show little improvement in knee function after surgery, and complain of a decrease in range of motion and functional mobility. Most evaluations of total knee replacement assessments are centered on levels of body structure and function. [35]

Indications of TKR

For total knee replacement, the most common indication and underlying diagnosis include the end-stage, degenerative osteoarthritis of the knee; nearly 94–97% of the knee replacement surgeries are conducted for primary or post-traumatic osteoarthritis.[34] In such patients, there should be presence of degenerative changes along with pain in addition to limitation of function in the knee, in which conservative and nonoperative measures are not successful. There are some other underlying diagnoses, which can be treated by knee replacement; these consist of periarticular fractures with secondary osteoarthritis,avascularnecrosis,rheumatoid arthritis ,inflammatory arthritis,haemophilic arthropathy or malignancy. Though,

megaprostheses are usually required in patients who have malignancy. [36]

Outcomes in TKR patients[37]

Total knee replacement is a major surgical procedure. Time to recovery can vary following TKR. Individual risk factors which impact on patient outcomes after TKR include age and gender, antecedent diagnosis, body mass index, ethnicity, psychological distress, baseline pain and functional disability, comorbidity profile, socioeconomic status, and radiographic osteoarthritis severity.

Rates of ongoing knee pain and functional impairment following TKR vary considerably in the literature, ranging from 14% to 44% of individuals reporting persistent pain and from 20% to 50% of individual was reporting functional impairment in the first 12 to 24 months following surgery. Of note the way in which data is captured and analysed, the level of follow-up, the types of patient-reported outcome measures (PROMs) used and the timing of their application also vary considerably between these studies. Numerous instruments for measuring the outcomes of TKR exist that include Oxford Knee Score (OKS), Knee Injury and Osteoarthritis Outcome Score (KOOS), Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), Knee Society Clinical Rating System (KSS), Visual Analogue Scale (VAS) and SF-36 score. [38,39]

Among the various factors that affect the outcome of TKR, we in this study analysed the bone mineral density (BMD). DEXA is an important diagnostic tool for detecting osteoporosis (BMD) in patients with OA and undergoing TKR. It serves as a promising supplement to x-ray scoring methods. [39]

DEXA scan

Currently, a dual energy X-ray absorptiometry (DXA) test performed from the lumbar spine or femoral neck is the gold standard in osteoporosis diagnostics. The result is expressed as a

standard deviation from the peak bone mineral density (BMD), called the T-score. The standard deviation from the mean BMD value for a given age is called the Z-score. [40]

According to the recommendations of the International Society for Clinical Densitometry (ISCD), the T-score is used in the case of men aged 50 or more and women after menopause. Then, the Z-score is used in the case of men below 50 years of age and women before menopause. [41] BMD assessment in the DXA test should be performed first based on the lumbar spine examination in persons below 65 years of age. [42]

The DEXA test measures BMD only, which is sometimes a very serious limitation. Test results in no way include the bone structure, which is equally important in the assessment of bone resistance to fracture.[41] Unfortunately, in the case of occurrence of degenerative lesions in an examined area, very often a BMD increase occurs, which in turn may lead to masking of osteoporosis in DXA tests and thus, underestimation of the risk of occurrence of fractures. [41] In extreme cases, even in compression fractures of vertebrae as a result of osteoporosis, BMD values may correspond to the normal bone density or osteopenia, which of course is inconsistent with the clinical condition of the patient. [41]

Relationship Between BMD and OA

The relationship of BMD and OA is a complex one. Literature review shows many controversial and conflicting results.

In 1972, Foss et al. were the first to observe the correlation between OA and fracture risk, concluding that patients with OA had a greater BMD for their age and thus had fewer hip fractures [43] This suggested the possibility of a protective effect of OA due to higher BMD, with several studies supporting the link between OA and higher BMD; Dequeker et al. [43] in 2003 reviewed the relationship between increased severity of OA resulting in higher

BMD scores, discovering 36 previous studies across 16 countries (Europe, the USA and Australia) covering a total of 37,774 subjects including 11,137 OA cases. Twenty-eight of these studies showed an increase in BMD with the remaining eight studies showing there was no increase in BMD. [44]

A study by Hart et al.[13] showed 95 women had a higher hip and spine BMD versus controls (0.79 versus 0.76 g/cm2, or 3.9%, and 1.01 versus 0.95 g/cm2, or 6.3%, for the hip and spine respectively); this itself is supported by other research[10] that concluded that OA resulted in higher BMDin the hip and spine, than women without hip OA. This trend was also seen in elderly men, who showed higher BMD in both the lumbar spine and hip compared to age-similar matched controls without OA.[43] This is further validated by research that shows an increase in BMD of the spine of patients with OA compared to controls.[43,44,45] There is research that states that although spine BMD might be high, hip BMD was not, as investigated by Lethbridge-Cejku et al.[46] who recruited 402 men and 247 women with OA. The results showed high levels of spine BMD but not hip BMD; this is supported by Arokoski et al.[46] whose findings suggest that hip OA is not associated with an increase of BMD in the femoral neck or in the head of the femur. It must be stated that there is also a small amount of research contrary to this that states OA lowers BMD compared to controls. [47]

The majority of the research shows an increase in BMD in OA patients, [46] but it must be acknowledged that there are other factors in OA; the phenotypes within OA such as osteophytic (which is osteophyte predominant)[45] and atrophic (which is joint space narrowing (JSN) predominant) both influence BMD scores. Out of the papers mentioned, only the Chaganti et al. [45] study directly referred to the phenotypes' impact; they showed significant differences in the hip and lumbar spine of areal BMD (aBMD)

measurements for the two radiographic hip OA (RHOA) phenotypes compared to the control group. The osteophytic RHOA group had a higher aBMD at all sites compared to the control group: + 3.9% at the total hip ($p = 0.002$), + 8.5% at the femoral neck ($p < 0.0001$), + 4.6% at the trochanter site ($p = 0.002$) and + 7.2% at the lumbar spine ($p = 0.0003$). In contrast, the atrophic phenotype was not significantly associated with any difference in aBMD compared to controls. [45]

The other studies mainly graded OA on a combination of factors resulting in a severity score; as such, these results might not be universal and may be more likely associated with the osteophytic phenotype. This is further supported by research that showed that obese patients have a more osteophyte dominant OA pattern compared to non-obese patients, 74.5% compared to 34.8%;[47] this coupled with increasing obesity in the population and the association of obesity with the onset and progression of OA in the knee resulting in more TKRs might reflect the associated BMD changed and OA diagnosis. Due to this recorded increase in BMD, it is generally thought that this would translate to having a protective effect on the bone by reducing fracture risk. [47]

This does not seem to be the case as several studies have argued against the protective nature of OA and actually demonstrate an increase in fracture risk. Reasons for this contradiction in correlation could be due to limitations in the DXA scans only measuring two dimensions and not accounting for bone depth.[47] Furthermore, research has demonstrated that osteophytes contribute between 16.6 and 22% of the lumbar spine BMD variation in DXA scans in women and men respectively, [47] possibly leading to an overestimation of higher BMD without the increase in bone strength; this might also explain the osteophyte phenotype predominance BMD results shown by Chaganti et al. risk of non-vertebral and hip fracture. [47]

It must be acknowledged that some studies have supported the idea of the OA protective effect; for example, Vestergaard et al. [47] conducted a case-control study using over 24,655 fractures matched for age and gender, with the main exposure being OA; their research showed that OA seemed to be associated with a decreased risk of fractures in multiple skeletal sites. This is agreed upon by Cumming and Klineberg[47] who had 189 participants (65–79 years old) with self-reported OA; the subjects with OA had fewer reported hip fractures than randomly assigned controls (4% compared to 13%). Additionally, Cumming et al. showed an inverse association between the number of joints reported to be affected by OA and the risk of hip fracture, with this protective effect being reported in both women and men. [57]

Other research has shown a lack of any relationship between OA and fracture risk despite increased BMD,[47] with additional research using cohort studies showing no relationship between fracture risk and OA, [47] contributing to the theory thatOA does not have a protective effect on fracture risk. Due to the contradiction and failure of the observed increase in BMD to translate into a protective effect and reduce fracture risk, several rationales were investigated. One rationale as to why an increased fracture risk may be explained, in part, was due to an increased fall tendency in patients with OA.[58]

Research has shown that people with knee or hip OA have a greater number of falls and fracture risk compared to the general population,[47] even showing an increase in odds of falling correlated to the number of affected joints with OA.This theory is shared by other research,[47] with some stating this is due to OA causing worsened postural stability and thus increasing the tendency to fall. This is contradicted however by two cohort studies[55,58] that reported that increased risk of fracture was independent of the number of falls. Although this in itself may be

explained due to the severity of the falls and not the number of falls.[55] However, this rationale may be difficult to justify as fall data is often incomplete.[47]

BMD, Fracture and TKR Relationship

The relationship between low BMD and increased fracture risk is well recognised, but the association between BMD scores, TKR and the associated fracture risk is not well established.[48]

The majority of the research shows a loss of BMD after a TKR (arthroplasty); Gazdzik et al.[49]

reported a decrease in BMD 12 months after TKR surgery with the most significant BMD decrease during the period of 5–12 weeks after the surgery at the periprosthetic region. Other research concurs with this, stating the greatest loss of periprosthetic BMD has been observed within the first 3 months (12 weeks) after surgery, [50] with some research reporting a temporary BMD loss of 13% at the proximal tibia. .[51]

This BMD loss is further supported by a study by Kimet al. [52] who investigated 48 Korean patients (11 males, 37 females, mean age 63 years) post-TKR; they reported a significant decrease in BMD at the trochanters and femoral neck in the first 3 months post-surgery, followed by a recovery of the BMD losses to − 2.14% at 12 months. A similar trend is seen across the research by Ishii et al.,[53] Hopkins et al..[54] and Petersen et al.[55] who all reported a decrease in total hip BMD during the first 6 months post-operatively. Other research investigated the effects of TKR 12 months post-operatively. Beaupre et al.[56] conducted a cohort study across 12 months and demonstrated that BMD decreased significantly by 1.80% at the total hip over that time. Soininvaara et al.6measured the BMD of bilateral hips in 69 patients undergoing total knee arthroplasty (TKA) (20 males, 49 females, mean age 67 years). They found a decrease in BMDat 12 months post-operatively of up to 2.7% per year in the ipsilateral hip and

up to 1.18% per year in the contralateral hip; this bone loss affecting the operated side more than the non-operated has been seen in other studies.[57] Mintzer et al.[58] reported that within the first 12 months post-operatively, 68% of patients had radiographic evidence of bone loss at the distal anterior femur. There are many more studies that have shown a correlation between TKR (arthroplasty) and BMD loss, [70] although there are some studies that dispute this association and have shown no change in BMD post-TKR/A,[59,60] with some research actually showing a small increase.[61] It is argued that BMD recovers to a baseline by 2 years, with research showing the greatest loss is within the first 2 years and eventually stabilizing at that point, although this in itself has been contested..[62] One explanation for this decline in BMD is a reduction in mobility of the patient post-surgery leading to reduced weight bearing and thus disuse related bone loss; this potentially explains the trend of such significant BMD reductions in the first 6 months and levelling out at 2 years post-operatively.[68]

Due to the majority of papers reporting a significant loss of BMD post-TKR/A, the possible associated fracture risk must be investigated. A study by Meek et al.[63] reported that women aged ≥ 70 years who had a TKR were 1.6 times more likely to have a fracture than younger patients and 2.3 times more likely to suffer a fracture than men. This is further supported by Toogood et al.[64] who stated that the greater majority of annual periprosthetic fractures were more often elderly and female. Preliminary results from the Sahlgrenska Academy in Mölndal[65] analysed medical records from 1987 to 2002, concluding that individuals who had a TKR had an increased risk for hip fracture by 4%, with the risk for vertebral fracture increasing by 19% compared to the population without TKR. The Prieto-Alhambra et al.[62] research supports this increase in hip fracture after TKR reporting that hip fracture rates were insignificantly reduced compared to controls

before the operation, but within 12 months post-operatively, TKR patients had a higher rate of hip fracture than controls, with relative risk increasing significantly up to 1.58 and then declining to equal the controls by 3 years. Additional research[61] has also shown a relationship between TKA and fracture risk, reporting a 54% increased risk of hip fracture, in particular among adult patients aged 71 years old, with the increase risk of hip fracture greatest after the first few years. Other research has shown an even higher figure, reporting a 58% increase in hip fracture in patients who had undergone TKR.[62]

This increase in fracture risk during the first few years is time-dependent and as such could be associated with the evidence that supports early BMD decline as an important predisposing factor contributing to fracture risk. There are other reasons put forward for the increased fracture risk in TKR patients, with some reports stating there is a higher incidence of falls thus a higher chance of fracture. Research by Matsumoto et al.[66] [86] reported that of 81 patients who underwent TKA, the incidence of falls was 38% in the first year post-operatively, compared to 24% in the non-TKA cohort. Additional research also shows a higher rate of falls indicating scores of between 23 and 43%.[67] Although some research contradicts this and shows fall incidences were not significantly higher in the TKR group.[69]

One possible intervention is antiresorptive treatment. Hahn and Won[76] investigated this, concluding that bisphosphate treatment just after TKR surgery prevented early BMD reduction in the hip and would be beneficial in the prevention of later hip fracture. This is supported by research by.

Carulli et al.,[68] who proposed the use of bisphosphonate treatment in patients to not only prevent bone loss but increase implant survival. Additionally, a meta-analysis.[69] in 2015 reviewed the long-term effects in using bisphosphonates, reporting a significant

decrease in implant revision after TKA or total hip arthroplasty (THA). Although caution should be utilised when administering bisphosphonates for long-term use, as research from 2017 has recently reported an increase in the size and number of microcracks leading to higher fracture risk in those patients on long-term bisphosphate use. Furthermore, there have been reports of long-term use leading to increased atypical femoral fractures.[70]

Previous empirical studies

Lingard et al.[71] investigated the prevalence of osteoporosis in patients with severe hip and knee OA awaiting joint arthroplasty and reported that the overall rate of osteoporosis was 23% and 43% of patients would have been classified as osteopenia. In our study, there were 32 cases (61.5%) of patients having low bone density, and 20 cases of patients diagnosed with osteoporosis. Labuda et al.[72] reported that osteoporosis is common in the osteoarthritic arthroplasty population, with a prevalence at least equal to that in the general population and suggested that osteoporosis assessment is needed in patients undergoing a joint replacement. There are many studies about BMD changes regarding the periprosthetic region after total joint replacement, but studies about BMD changes of axial bone after total joint replacement in patients with OA are limited.

Gazdzik et al.[64] reported that a decrease in BMD was observed in all determined regions within one year after the surgery and the most significant BMD decrease at the periprosthetic region was observed in the period between 5-12 weeks after the knee joint arthroplasty, the result furthermore shows increased bone resorption and decreased motor activity of the patients. So they recommended early patient rehabilitation and loading of the operated extremity.

Ishii et al.[68] investigated the relationship between TKR and BMD in the same and opposite hips and reported that there was no

statistical difference among preoperative, 6 months, 1 year, 2 years after TKR and 45% of the hips on the operative side and 59% of the hips on the non-operative side at 2 years after TKR had higher BMD than preoperative levels.

However, Soininvaara et al.6checked the BMD in the proximal femur and contralateral knee at one year after TKR and reported neither the hip nor the non-operated knee BMDs increased and concluded that improved mobility after TKR does not improve the effects of preoperative disuse associaated with bone loss in the short term. However, in their study, the spine BMD was increased and hip BMD was decreased in non-treatment group at 1 year after TKR.

Studies concerning the relationship between OA and fractures by Bergink et al.[73] investigated the association between prevalent radiographic OA of the knee and incident vertebral and non-vertebral fracture and reported that the knee OA is associated with an increased risk of in cidental vertebral and non-vertebral fracture, independent of BMD and parameters of postural stability.

Ardenet al.[55] reported prevalent knee pain was associated with an increased risk of falling (hazard ratio [HR] 1.26. 95% confidence interval [CI] 1.17-1.36) and hip fracture (HR 2.0 95% CI 1.18-3.37). And they suggested knee pain and OA should be regarded as independent risk factors for fracture.

Joshi et al.[74] reported 4 cases of ipsilateral fracture of the femoral neck after TKR. They explained possible mechanisms of fractures are due to changes in the weight bearing axis of the extremity and poor mobility and weakened bones. So they suggested graduating weight bearing, treating osteoporosis and using less constrained devices may avoid stress fracture of the femoral neck after TKR.

Prieto Alhambra et al[62] investigated changes of hip fracture rate before and after TKR due to OA and reported hip fracture rates

were insignificantly reduced before the operation but, in the year after TKR, relative risk increased significantly up to 1.58 and then declined to equal by 3 years compared with controls. Recently, bisphosphonate are being prescribed as first choice drug for osteoporosis. And common mechanisms of failure of TKR are represented by aseptic loosening, infection, and instability. Biologic mechanisms related aseptic loosening are large amount of activated macrophages, high concentration of specific cytokines, and presence of bone resorption by osteoclasts.[75]

Carulli et al.[83] proposed the use of bisphosphonate in patients undergoing a joint arthroplasty to reduce the progressive bone loss at the counterface between components and bone, to im prove implant survival, and to prevent loosening. Hence, bisphosphonate treatment after TKR not only helps strengthen the osteoporotic bone but it also prevents aseptic loosening of implants.

Wang et al.[76] evaluated the long term effects of bisphosphonate on periprosthetic BMD changes after TKR. They reported BMD increased at six and 12 months after TKR but no significant difference was noted after thirty-six months.

Prieto-Alhambra et al.[77] (2011) assessed the effect of bisphosphonate use on post TKR fracture risk and reported that the HR associated with bisphosphonate therapy after TKR was 0.5 in non-fractured patients previously and 0.45 in subjects with osteoporotic and with other previous fracture. This suggested bisphosphonate treatment after TKR reduced the risk of fracture by 50-55%.

Lee et al.[78] (2013) reported that BMD declined in more than half of the patients, even though they took the bisphosphonate treatment for only 1 year after TKR, this decline was significant in bilateral TKR patients. Moreover patients undergoing bilateral TKR, who had more severe OA at baseline had a lower BMD response

after 2 years of bisphosphonate treatment, compared with patients with less severe unilateral knee OA who underwent unilateral TKR.[79] However, in the study, in bisphosphonate treatment group, total hip BMD was significantly increased compared to non-treatment group regardless of operation sites whether unilateral or bilateral and osteoporosis diagnosis.

Dincel YM et al (2020)[80] in a prospective study aimed to investigate the change in bone mineral density (BMD) in the first postoperative year in 76 patients that underwent total knee arthroplasty (TKA) due to primary osteoarthritis of the knee. Both the T and Z scores of the spine (L1-L4) and proximal femur showed a slightly positive trend, however, with an insignificant statistical difference ($p \geq 0.05$). It was concluded that patients that underwent TKA experienced a statistically insignificant bone gain at the spine and proximal femur twelve months after the surgery.

MATERIALS AND METHODS

1. Study Site:

The study was conducted at the Department of Orthopaedics, Dayanand Medical College, and Ludhiana.

2. Study Population:

The study included admitted patients for elective total knee replacements who were analyzed under a period of 6 months at the Department of Orthopaedics, Dayanand Medical College, Ludhiana. Patients were diagnosed based on clinical, serological and radiological criteria.

Inclusion criteria

- Patients who underwent primary TKR for knee arthritis.

Exclusion criteria

- Patients who underwent revision knee replacement previously
- Patients who have undergone any previous surgery at knee joint
- Patients having congenital deformity of one or both the lower limbs
- Patients having pathological fracture or tumor around the knee joint
- Patients with concomitant hip or spine deformities

3. Study Design: Prospective Interventional Cohort Study.

4. Sample Size:

The study of Yasar Mahsut Dincel, et al[97] observed that pre and post operative T score of the L1-L4 section was -0.6934 and -0.6763 respectively. Taking these values as reference and assuming standard deviation of 0.03, the minimum required sample size with 90% power of study and 5% level of significance is 33 patients. Taking lost to follow up as 20%, total sample size to be taken is 42.

Formula used is:

For comparing mean of pre and post

$$N >= \frac{(\text{standard deviation})^2 * (Z_\alpha + Z_\beta)^2}{(\text{mean difference})^2}$$

Where Z_α is value of Z at two sided alpha error of 5% and Z_β is value of Z at power of 90% and mean difference is difference in mean values of pre and post.

Calculations:

$N >= \frac{(0.03)^2 * (1.96 + 1.28)^2}{(0.0171)^2} >= 32.31 = 33$(approx.)

Taking lost to follow up as 20%, n>=33/.8=41.25=42(approx.)

5. Sampling Technique:

Patients who were admitted for elective total knee replacements at the Department of Orthopaedics, Dayanand Medical College, Ludhiana were selected with sample random sampling after applying the relevant inclusion and exclusion criteria.

6. STUDY DURATION

The study was conducted over a period of 2 years (prospective study) with minimum follow up of 6 months.

7. Methodology

Data of patients who satisfied the eligibility criteria were included in the study. A written informed consent was taken from the patients. The ethical clearance certificate was taken from the ethical committee of the institute.

The complete demographic, personal and clinical history was taken. A history of co-morbidities such as hypertension, diabetes, and smoking status were determined. The preliminary history and examination details were filled in the study proforma.

Patients were assessed preoperatively using a proforma having two parts- to be filled by the clinician and the patient respectively, BMD at the lumbar and hip region were measured by dual energy X-ray absorptiometry (DEXA) with supine position. The bone density of the lumbar region (L1-L4), left femoral neck and left total hip density were measured. Postoperative BMD was measured by same machine and same way. Osteoporosis was defined by a T-score -2.5 or less and osteopenia was defined by a T-score -2.5 between -1 at the lumbar, femoral neck and total hip region whichever was lowest according to

the World Health Organization (WHO) International reference standard.[81] Patients were re-assessed at a minimum of six months follow-up period.

Table 1M: World Health Organization (WHO) definition of osteoporosis and osteopaenia according to T-score.98

Stage	**T-Score value**
Normal	> -1
Osteopaenia	[-1, -2.5]
Osteoporosis	< -2.5
Severe osteoporosis	< -2.5 ± 1 fragility fracture

Investigations

Preoperative investigations

Hb%, TLC, DLC, Hematocrit

Liver function test

Kidney function test

Viral markers

Chest x-ray

X-ray of both knees

ECG

PT/APTT/INR

Postoperative investigations

Hb%, TLC, DLC,

KFT

Surgery

TKA was performed using tourniquet until prostheses is implanted; administration of antibiotics and prophylaxis against venous thrombosis through the standard approach with medial para-patellar arthrotomy was given after an informed consent from the patients for the surgery.

Following TKA preferences were predetermined: femur varus/valgus 0° (perpendicular to mechanical axis), flexion/extension 3° of flexion, rotation 0° (parallel to trans-epicondylar axis); tibia varus/valgus 0° (perpendicular to mechanical axis), posterior slope 3°, rotation 0° [from antero-posterior (A/P) axis].

Rehabilitation was commenced on the first postoperative day. At discharge, patients were able to perform at least 90° flexion of the knee joint and moved efficiently using elbow crutches.Knee range of motion and knee axis was measured with a goniometer.

8. Outcome measures

- Changes in the BMD

9. Statistical analysis

Data was described in terms of range; mean ±standard deviation (± SD), median, frequencies (number of cases) and relative frequencies (percentages) as appropriate. Comparison of quantitative variables between the study groups was done using ANOVA. For comparing categorical data, Chi square ($\chi 2$) test was performed and exact test was used when the expected frequency was less than 5. A probability value (p value) less than 0.05 was considered statistically significant. All statistical calculations were done using SPSS (Statistical Package for the Social Science) SPSS 21 version statistical program for Microsoft Windows.

10. Ethical considerations

Ethical clearance was obtained from the Institutional Ethical Committee, prior to the start of the study

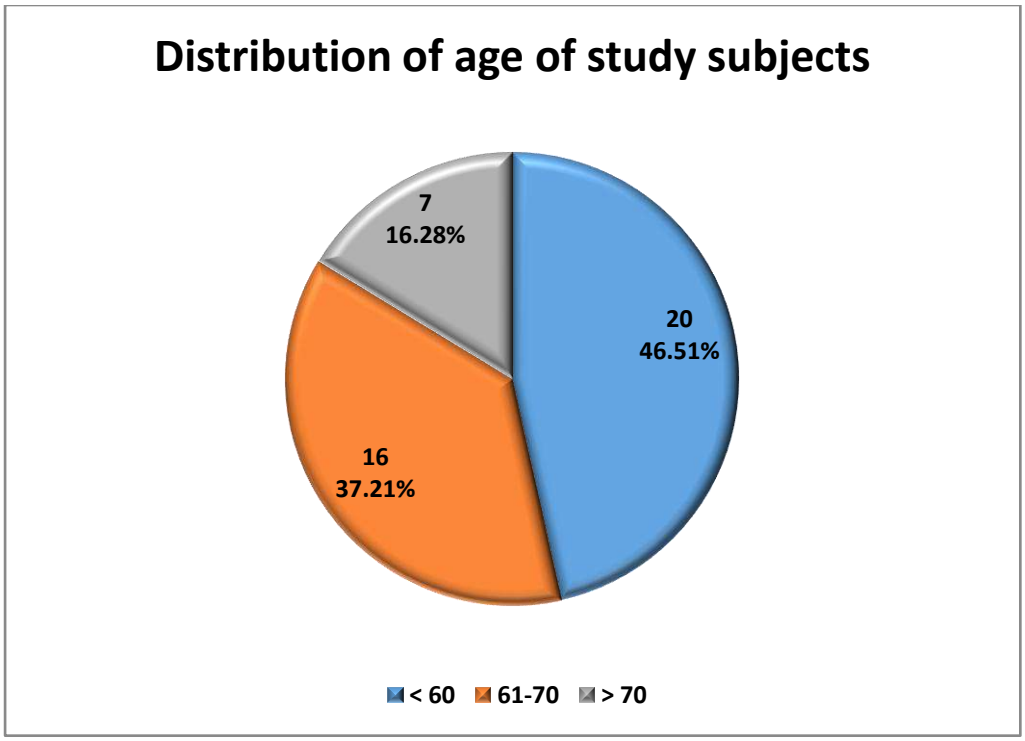
- written informed consent was taken from all study participants
- Confidentiality and privacy was ensured at all stages.

Results and observations

Table 1:-Distribution of age of study subjects.

Age (in years)	No. of cases	Percentage
< 60	20	46.5%
61-70	16	37.2%
> 70	7	16.3%
Total	43	100.0%

Figure 1:-Distribution of age of study subjects.

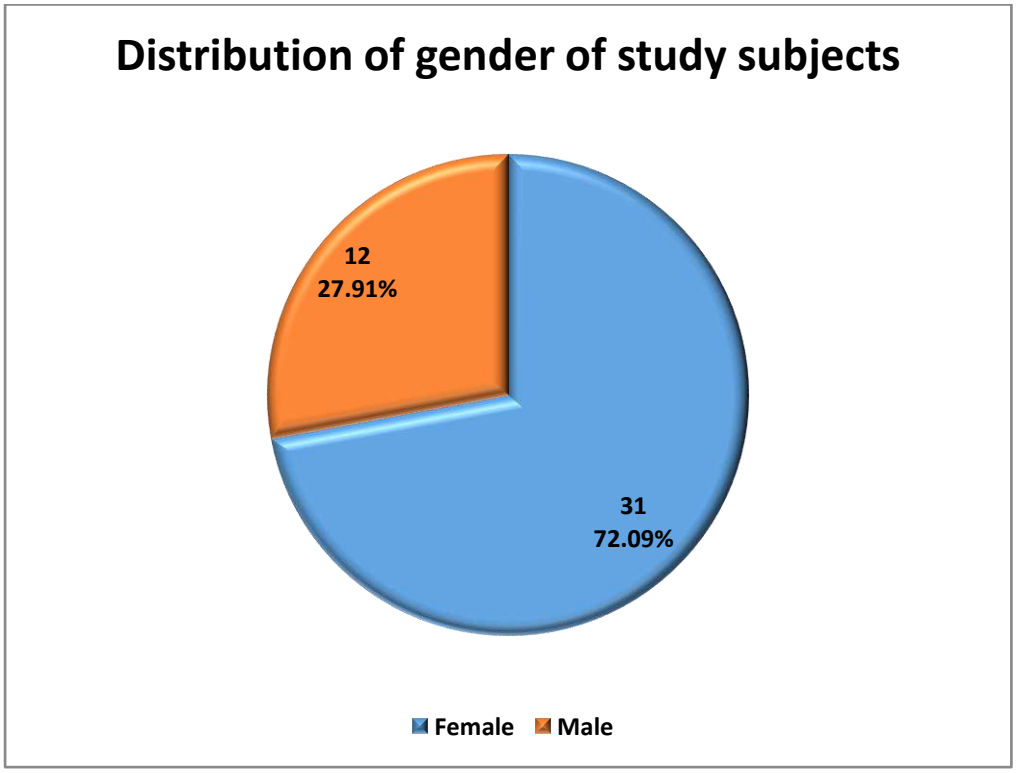


In present study, 46.5% of patients belonged to age group <60 years followed by 61-70 years (37.2%). Age group was >70 years of only 7 out of 43 patients (16.3%). It is shown in table 1, figure 1.

Table 2:-Distribution of gender of study subjects.

Gender	No. of cases	Percentage
Female	31	72.1%
Male	12	27.9%
Total	43	100.0%

Figure 2:-Distribution of gender of study subjects.

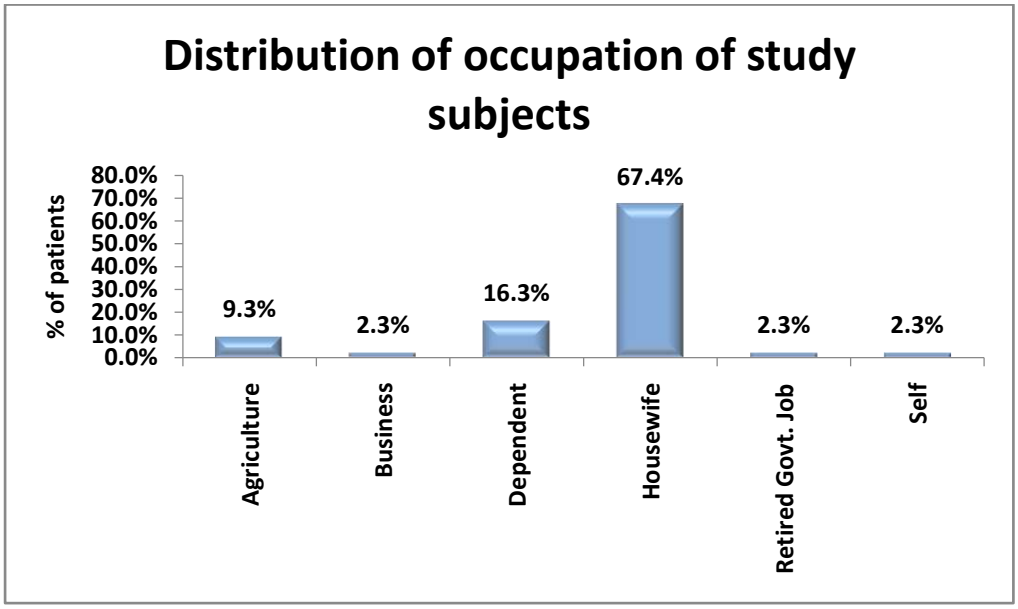


In present study, 72.1% of patients were females and 27.9% of patients were males. It is shown in table 2, figure 2.

Table 3:-Distribution of occupation of study subjects.

Occupation of Self	No. of cases	Percentage
Agriculture	4	9.3%
Business	1	2.3%
Dependent	7	16.3%
Housewife	29	67.4%
Retired Govt. Job	1	2.3%
Self	1	2.3%
Total	43	100.0%

Figure 3:-Distribution of occupation of study subjects.

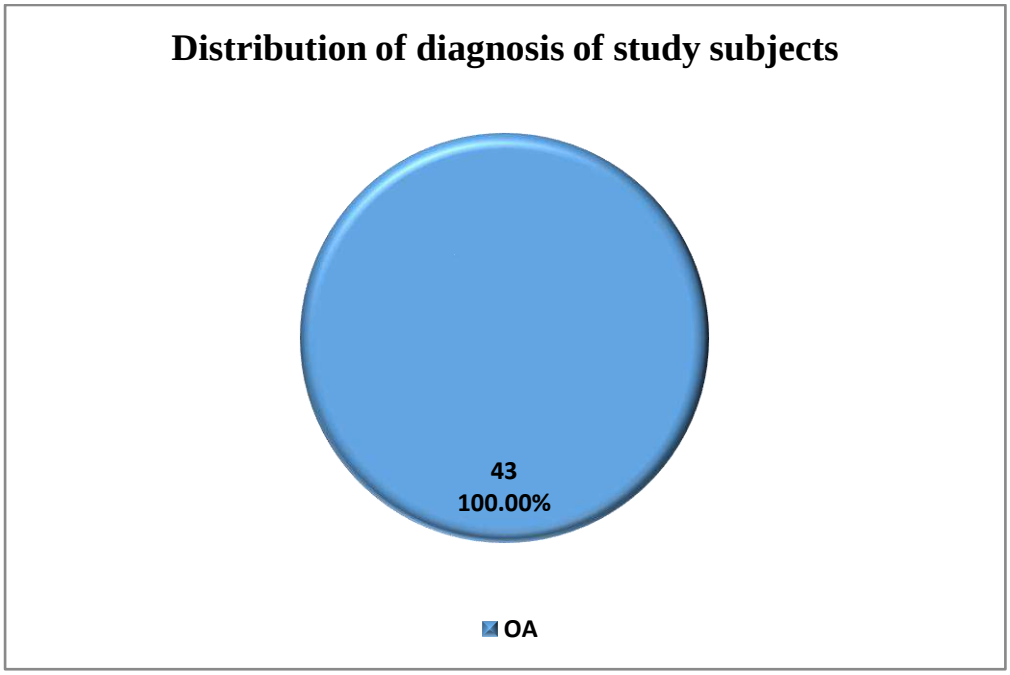


In present study, majority (67.4%) of study subjects were housewives followed by dependent (16.3%) and 9.3% of patients were engaged in agriculture. Only 1 out of 43 were doing business, retired Govt. Job and Self each (2.3%). It is shown in table 3, figure 3.

Table 4:-Distribution of diagnosis of study subjects.

Diagnosis	No. of cases	Percentage
OA	43	100.0%
Total	43	100.0%

Figure 4:-Distribution of diagnosis of study subjects.

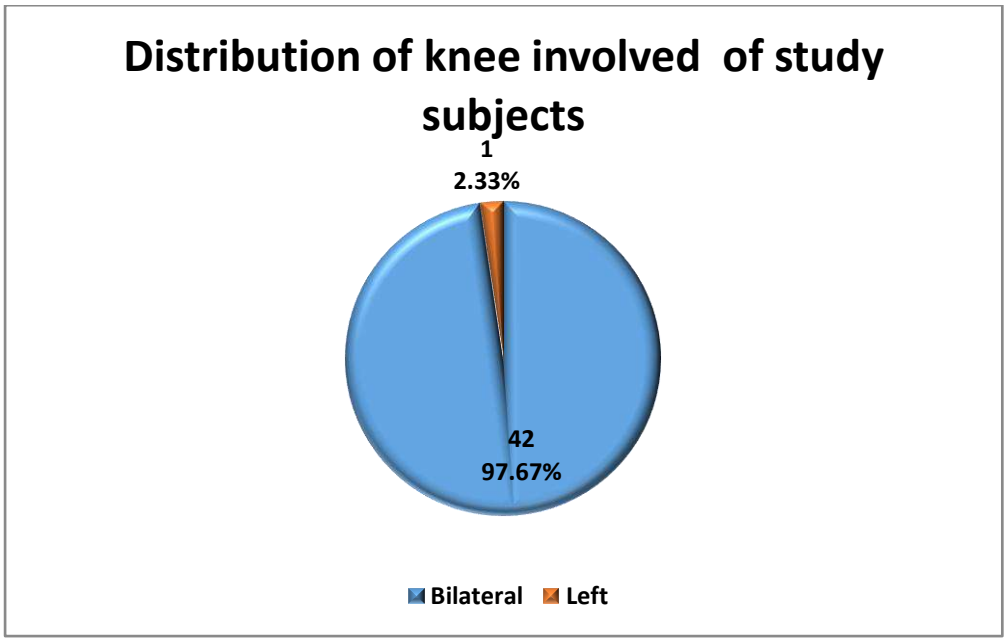


In present study, all 43 cases were OA (100%).It is shown in table 4, figure 4.

Table 5:- Distribution of knee involved of study subjects.

Knee involved	No. of cases	Percentage
Bilateral	42	97.7%
Left	1	2.3%
Total	43	100.0%

Figure 5:-Distribution of knee involved of study subjects.

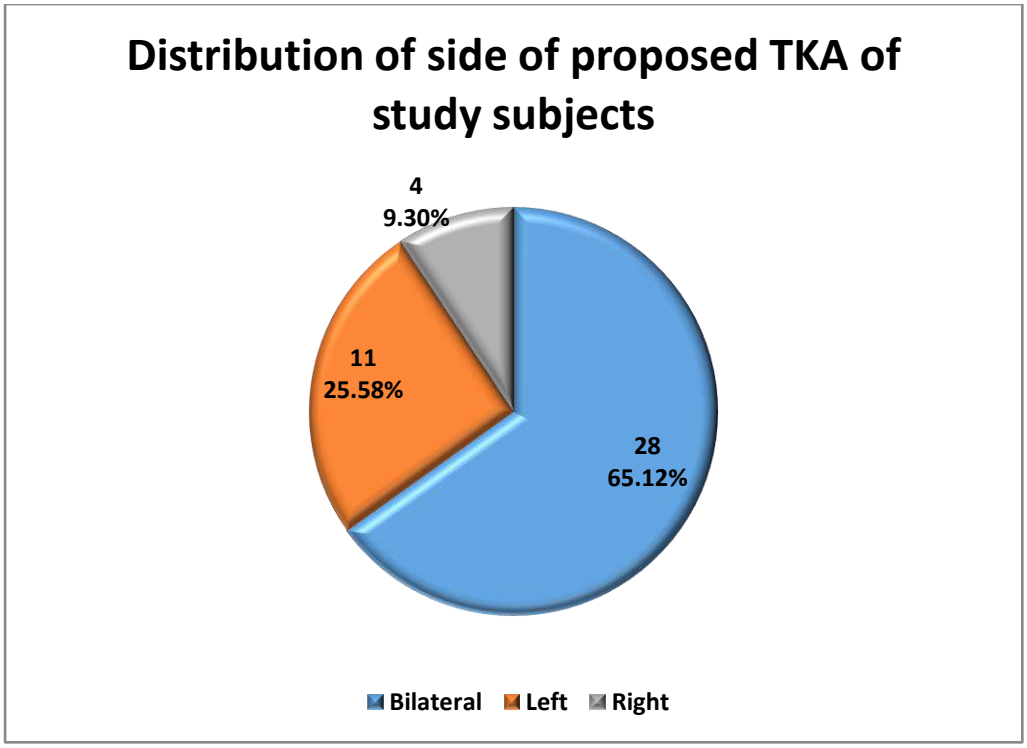


In present study, knee involved was bilateral (97.7%). Left knee was involved in only 1 out of 43 patients (2.3%). It is shown in table 5, figure 5.

Table 6:-Distribution of side of proposed TKA of study subjects.

Side of proposed TKA	No. of cases	Percentage
Bilateral	28	65.12%
Left	11	25.58%
Right	4	9.30%
Total	43	100.0%

Figure 6:-Distribution of side of proposed TKA of study subjects.

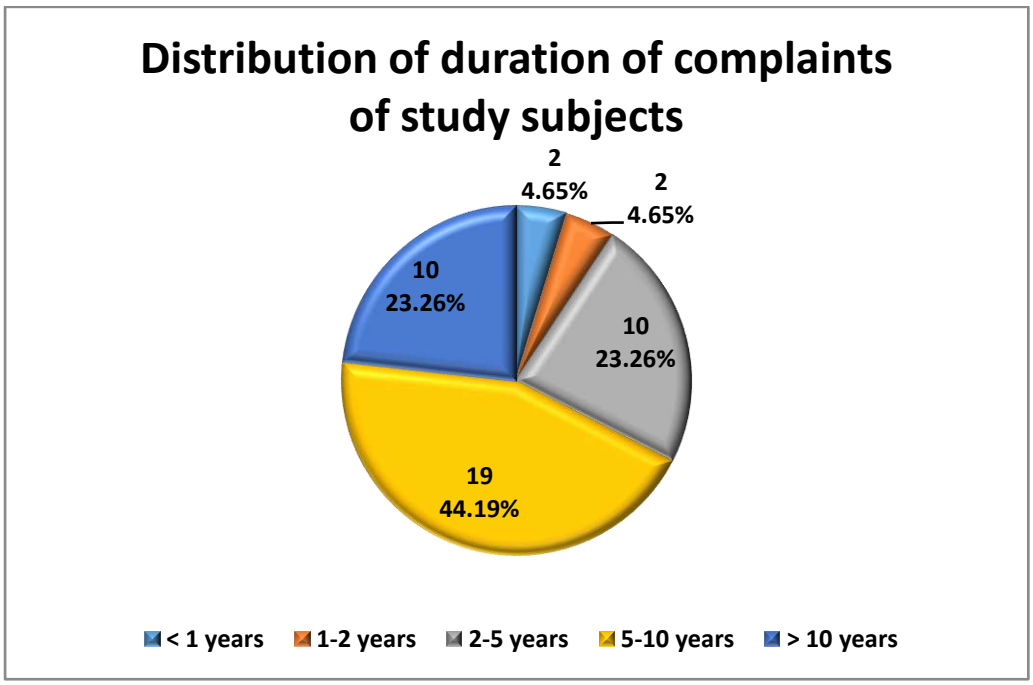


In present study, proposed TKA in 65.12% of patients was bilateral followed by Left (25.58%) and right side (9.30%). It is shown in table 6, figure 6.

Table 7:-Distribution ofduration of complaints of study subjects.

Duration of Complaints	No. of cases	Percentage
< 1 years	2	4.7%
1-2 years	2	4.7%
2-5 years	10	23.3%
5-10 years	19	44.2%
> 10 years	10	23.3%
Total	43	100.0%

Figure 7:-Distribution of duration of complaints of study subjects.

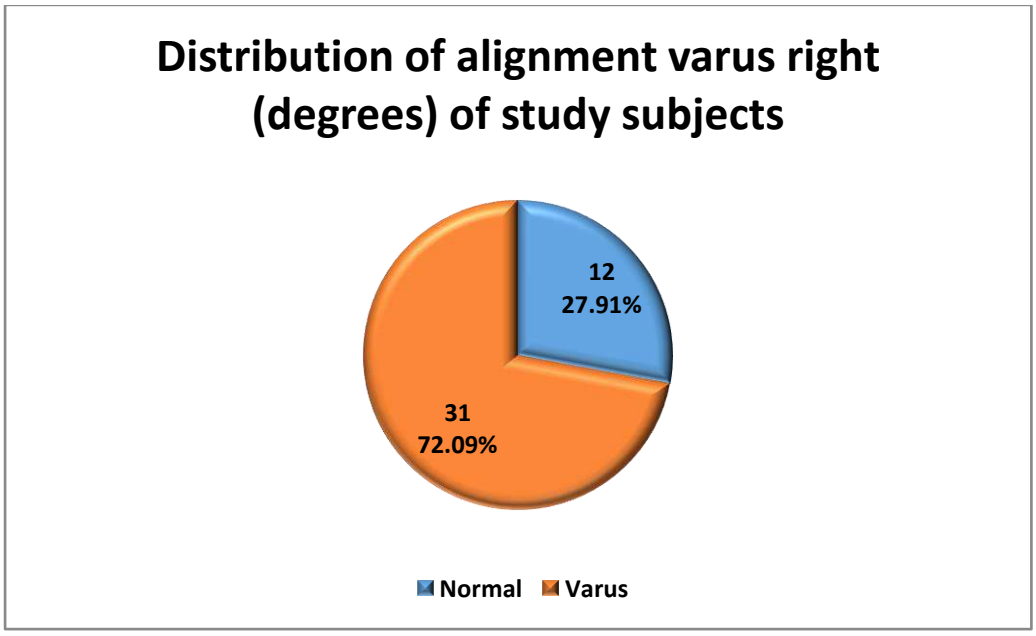


In present study, duration of complaints was 5-10 years in majority (44.2%) of patients followed by 2-5 years (23.3%) and >10 years (23.3%). 2 out of 43 patients (4.7%) had duration of complaints <1 year and 1-2 years.It is shown in table 7, figure 7.

Table 8:-Distribution of alignment varus right (degrees) of study subjects.

Alignment Varus Right (degrees)	No. of cases	Percentage
Normal	12	27.9%
Varus	31	72.1%
Total	43	100.0%

Figure 8:-Distribution of alignment varus right (degrees) of study subjects.

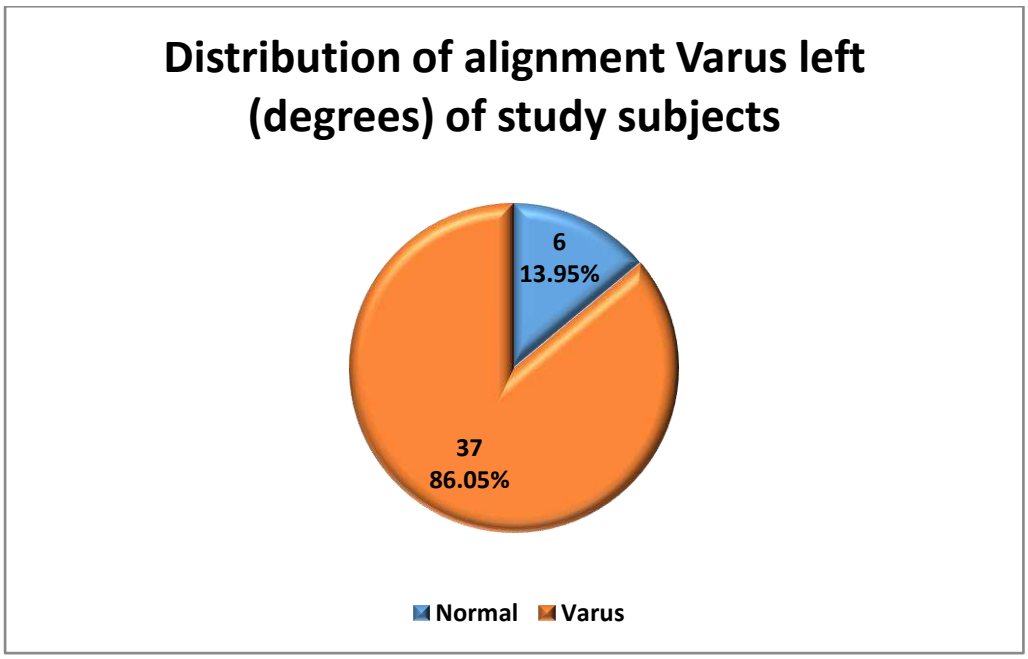


Alignment was normal in right side in 27.9% of patients and varus deformity was present in 72.1% of patients. It is shown in table 8, figure 8.

Table 9:-Distribution of alignment varus left (degrees) of study subjects.

Alignment varusleft (degrees)	No. of cases	Percentage
Normal	6	14.0%
Varus	37	86.0%
Total	43	100.0%

Figure 9:-Distribution of alignment varus left (degrees) of study subjects.

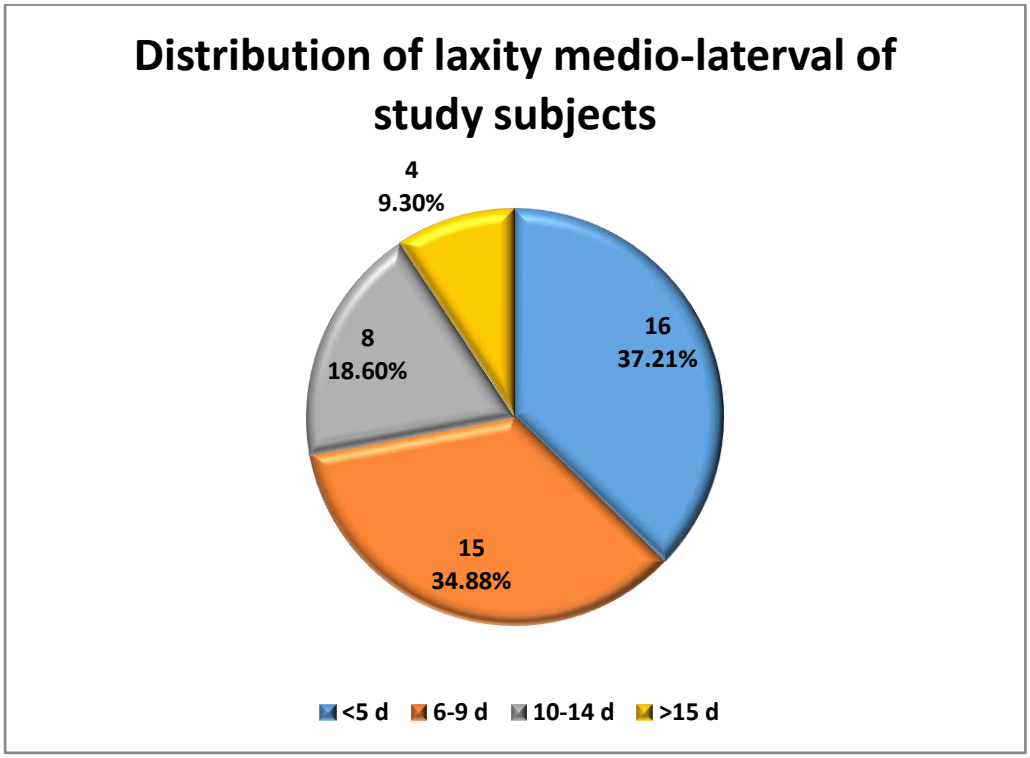


Alignment was normal in left side in 14% of patients and varus deformity was present in 86% of patients.It is shown in table 9, figure 9.

Table 10:-Distribution of loaxitymedio-laterval of study subjects.

Laxity Medio-laterval	No. of cases	Percentage
<5 d	16	37.2%
6-9 d	15	34.9%
10-14 d	8	18.6%
>15 d	4	9.3%
Total	43	100.0%

Figure 10:-Distribution of loaxitymedio-laterval of study subjects.

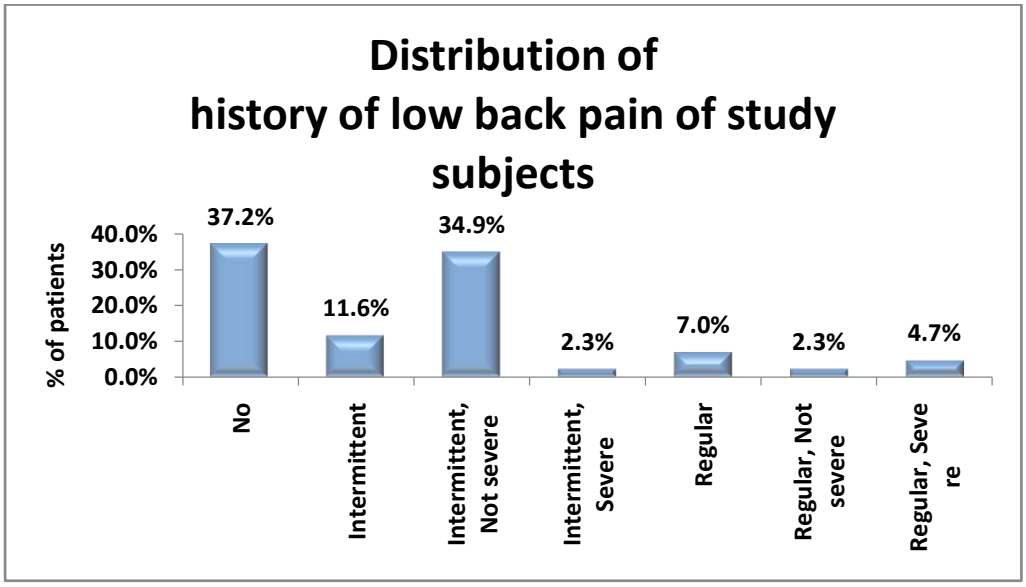


In present study, laxity mediolaterval was <5 days in majority (37.2%) of patients followed by 6-9 days (34.9%), 10-14 days (18.6%). 4 out of 43 patients (9.3%) had >15 days of laxity mediolaterval. It is shown in table 10, figure 10.

Table 11:-Distribution of history of low back pain of study subjects.

History of low back pain	No. of cases	Percentage
No	16	37.2%
Intermittent	5	11.6%
Intermittent, Not severe	15	34.9%
Intermittent, Severe	1	2.3%
Regular	3	7.0%
Regular, Not severe	1	2.3%
Regular, Severe	2	4.7%
Total	43	100.0%

Figure 11:-Distribution of history of low back pain of study subjects.



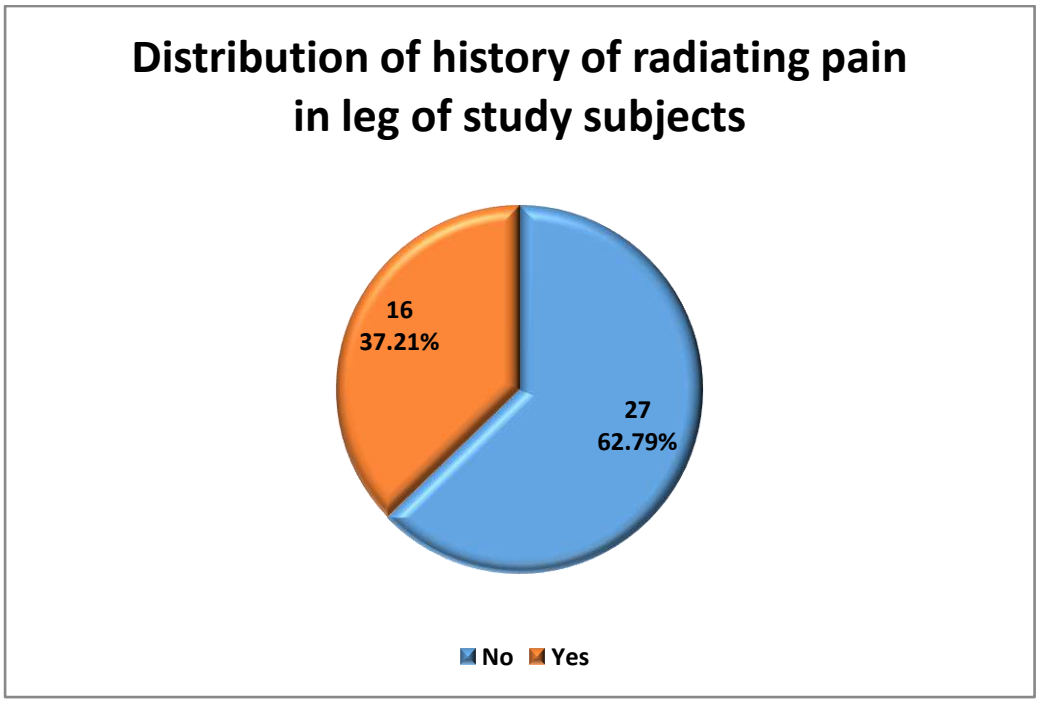
In present study, majority (37.2%) of patients had no history of low back pain. 34.9% of patients had intermittent but not severe law back pain history. 5 out of 43 patients had intermittent law back pain history (11.6%). History of regular low back pain was present in 7% of patients, regular and severe low back pain was seen in 4.7% of patients and only 2.3% of patients had intermittent and severe history

of low back pain and regular and not severe history of low back pain each. It is shown in table 11, figure 11.

Table 12:-Distribution of history of radiating pain in leg of study subjects.

History of radiating pain in leg	No. of cases	Percentage
No	27	62.8%
Yes	16	37.2%
Total	43	100.0%

Figure 12:-Distribution of history of radiating pain in leg of study subjects.

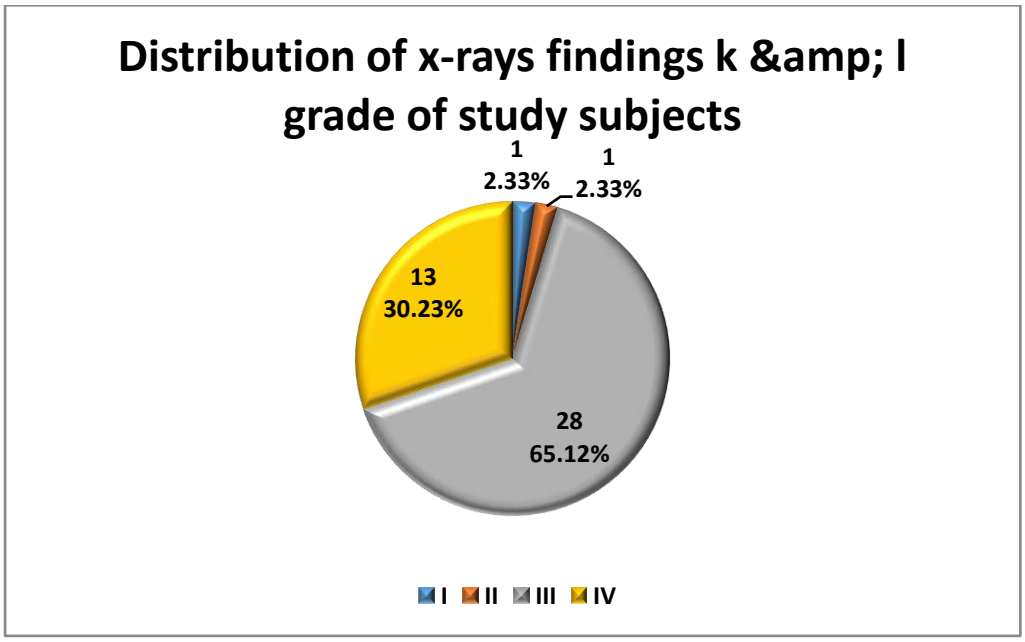


In present study, majority (62.8%) of patients had no history of radiating pain in leg. Radiating pain in leg history was present in only 16 out of 43 patients (37.20%). It is shown in table 12, figure 12.

Table 13:-Distribution of x-rays findings k & l grade of study subjects.

X-Rays Findings K & L Grade	No. of cases	Percentage
I	1	2.3%
II	1	2.3%
III	28	65.1%
IV	13	30.2%
Total	43	100.0%

Figure 13:-Distribution of x-rays findings k & l grade of study subjects.

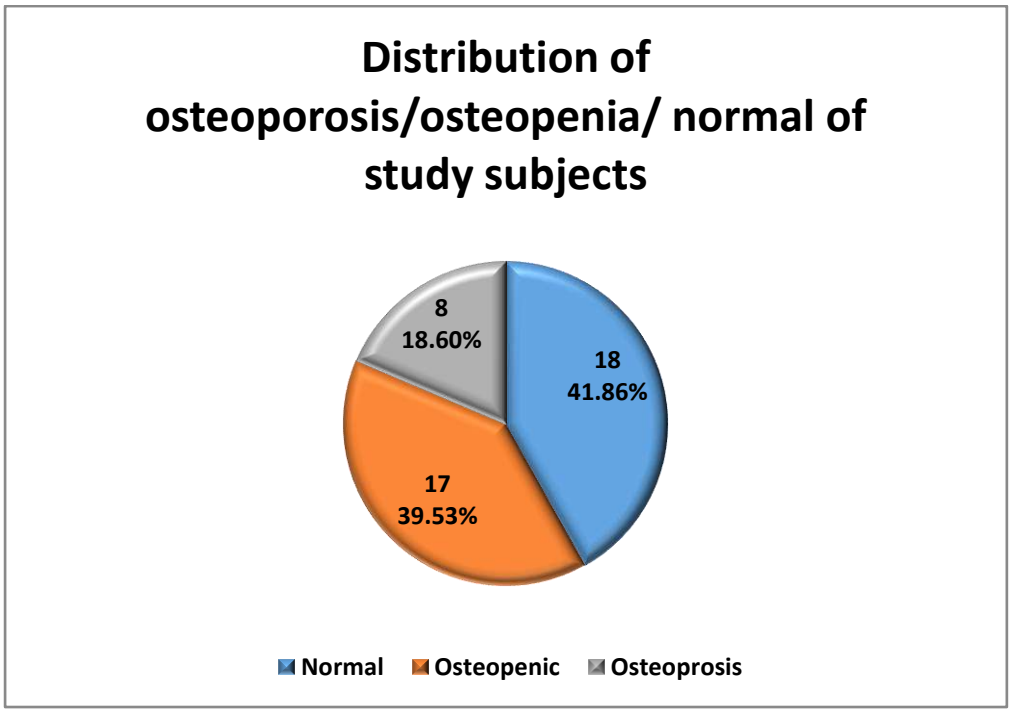


In present study, majority (65.1%) of patients had grade III, followed by grade IV (30.2%). Only 1 out of 43 patients (2.3%) had grade I and grade II each. It is shown in table 13, figure 13.

Table 14:-Distribution of osteoporosis/osteopenia/ normal of study subjects.

Osteoporosis/Osteopenia/ Normal	No. of cases	Percentage
Normal	18	41.9%
Osteopenic	17	39.5%
Osteoprosis	8	18.6%
Total	43	100.0%

Figure 14:-Distribution of osteoporosis/osteopenia/ normal of study subjects.

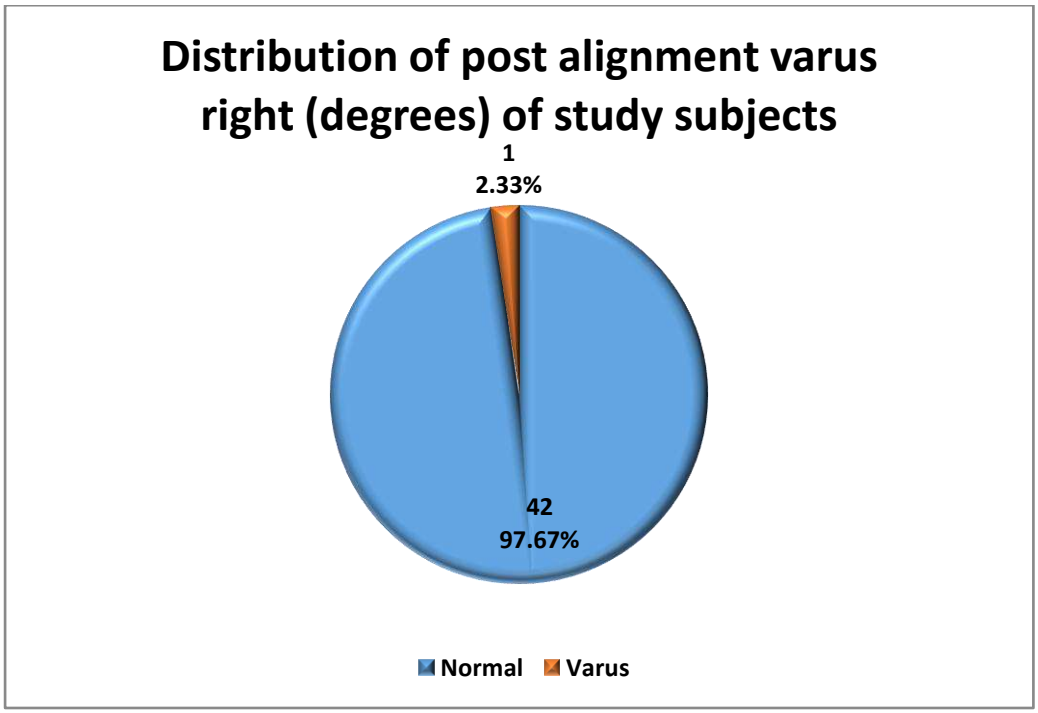


In present study, majority (41.9%) patientshad normal BMD followed by osteopenic (39.5%). Only 8 out of 43 patients (18.6%) had osteoprosis. It is shown in table 14, figure 14.

Table 15:-Distribution of post alignment varus right (degrees) of study subjects.

Post Alignment Varus Right (degrees)	No. of cases	Percentage
Normal	42	97.7%
Varus	1	2.3%
Total	43	100.0%

Figure 15:-Distribution of post alignment varus right (degrees) of study subjects.

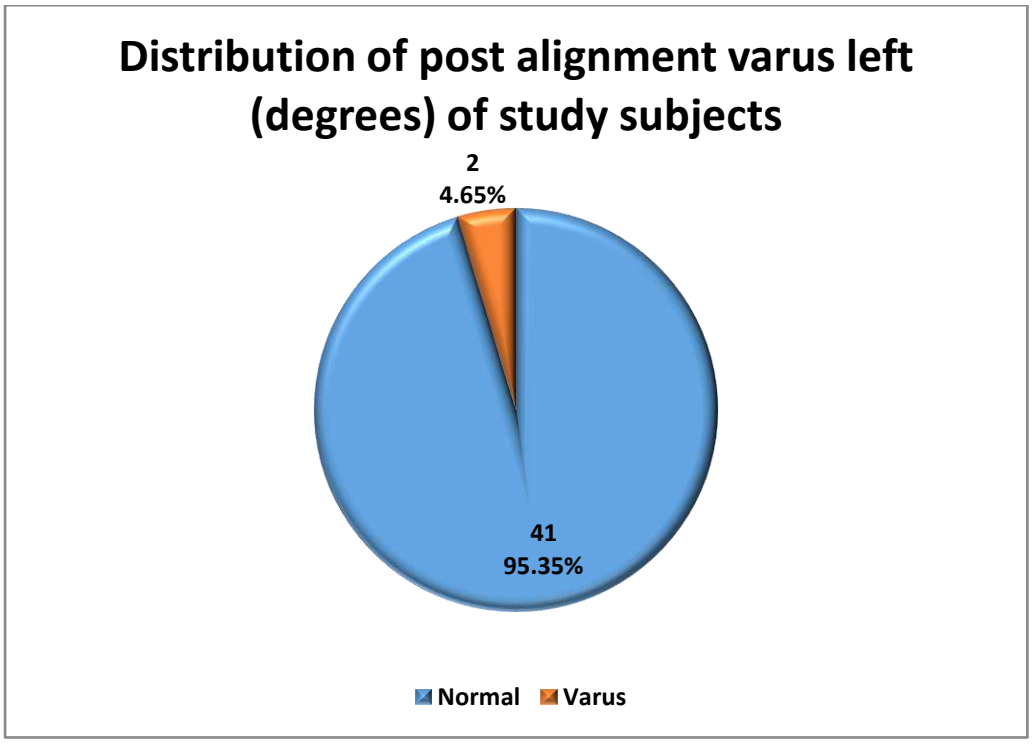


Post alignment was normal in right side in 97.7% of patients and varus deformity was present in 2.3% of patients. It is shown in table 15, figure 15.

Table 16:-Distribution of post alignment varus left (degrees) of study subjects.

Post Alignment Varus Left (degrees)	No. of cases	Percentage
Normal	41	95.3%
Varus	2	4.7%
Total	43	100.0%

Figure 16:-Distribution of post alignment varus left (degrees) of study subjects.

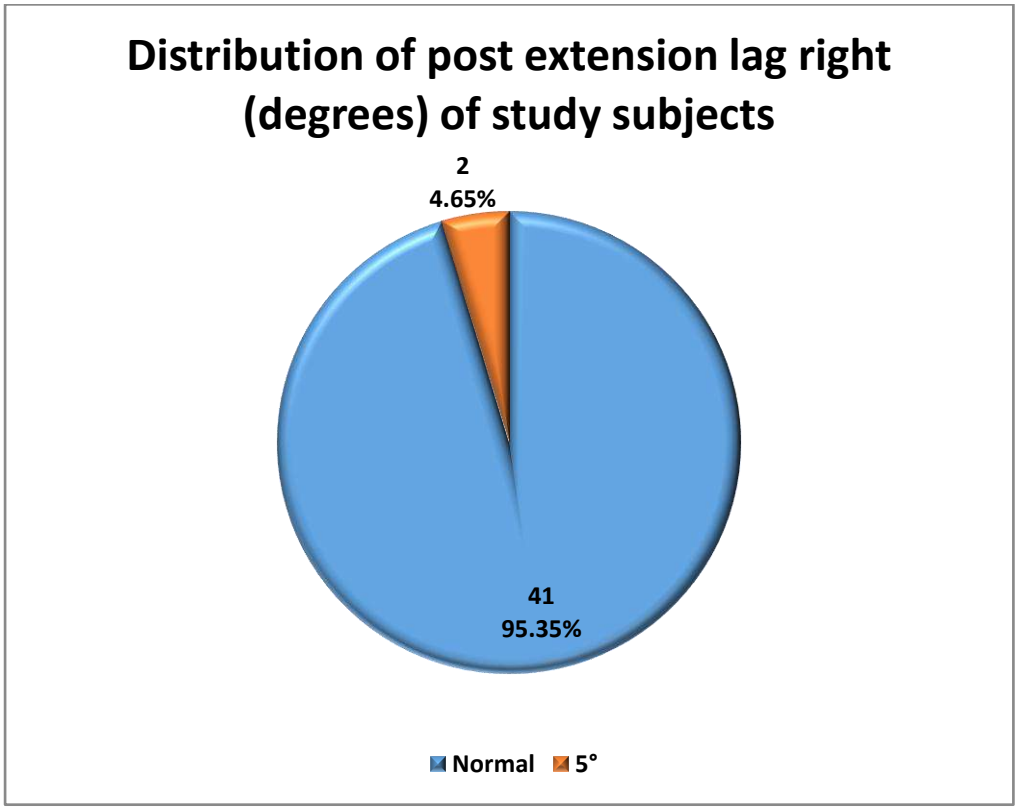


Post alignment was normal in left side in 95.3% of patients and varus deformity was present in 4.7% of patients. It is shown in table 16, figure 16.

Table 17:-Distribution of post extension lag right (degrees) of study subjects.

Post Extension Lag Right (degrees)	No. of cases	Percentage
Normal	41	95.3%
5°	2	4.7%
Total	43	100.0%

Figure 17:-Distribution of post extension lag right (degrees) of study subjects.

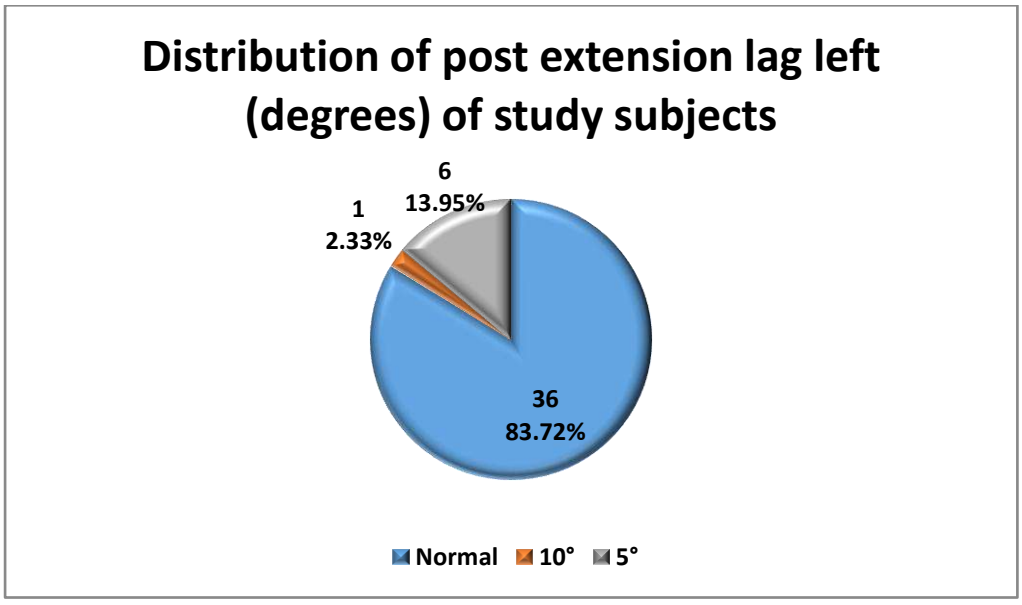


In the present study, 4.7% of patients had 5° of post extension left lag. It is shown in table 17, figure 17.

Table 18:-Distribution of post extension lag left (degrees) of study subjects.

Post Extension Lag Left (degrees)	No. of cases	Percentage
Normal	36	83.7%
10°	1	2.3%
5°	6	14.0%
Total	43	100.0%

Figure 18:-Distribution of post extension lag left (degrees) of study subjects.



In the present study, 14% of patients had 5° of post extension left lag. 1 out of 43 patients (2.3%) had 10° of post extension left lag. It is shown in table 18, figure 18.

Table 19:-Descriptive statistics of parameters of study subjects.

Parameters	N	Mean ± SD	Range
Age (in years)	43	61.55 ± 9.27	37.2 - 80.9
Weight (in kg)	43	76.93 ± 13.2	50 - 104
Height (in cm)	43	157.4 ± 9.07	135 - 177
ROM Right (degrees)	43	93.95 ± 5.41	80 - 100
ROM Left (degrees)	43	94.42 ± 5.02	90 - 100
S. Vitamin D Level	42	26.17 ± 13.83	7.29 - 81.97
S. Calcium Level	42	8.34 ± 0.91	5.4 - 10.1
AP Spine BMD Score	43	1.12 ± 0.19	0.71–1.50
AP Spine T Score	43	-0.61 ± 1.52	-3.70 - 2.4
B/L Femur BMDscore	43	0.9 ± 0.22	0.017 - 1.32
B/L Femur T score	43	-0.9 ± 1.26	-2.7 - 1.6
Post Range of Motion Right (degrees)	43	115.35 ± 8.82	90 - 120
Post Range of Motion Left (degrees)	43	116.28 ± 8.74	90 - 130
Post AP Spine BMD Score	42	1.13 ± 0.18	0.766 - 1.503
Post AP Spine T Score	42	-0.49 ± 1.47	-3.5 - 2.4
Post B/L Femur BMD Score	42	0.94 ± 0.18	0.657 - 1.32
Post B/L Femur T Score	42	-0.65 ± 1.3	-2.7 - 1.7

Figure 19:-Descriptive statistics of parameters of study subjects.

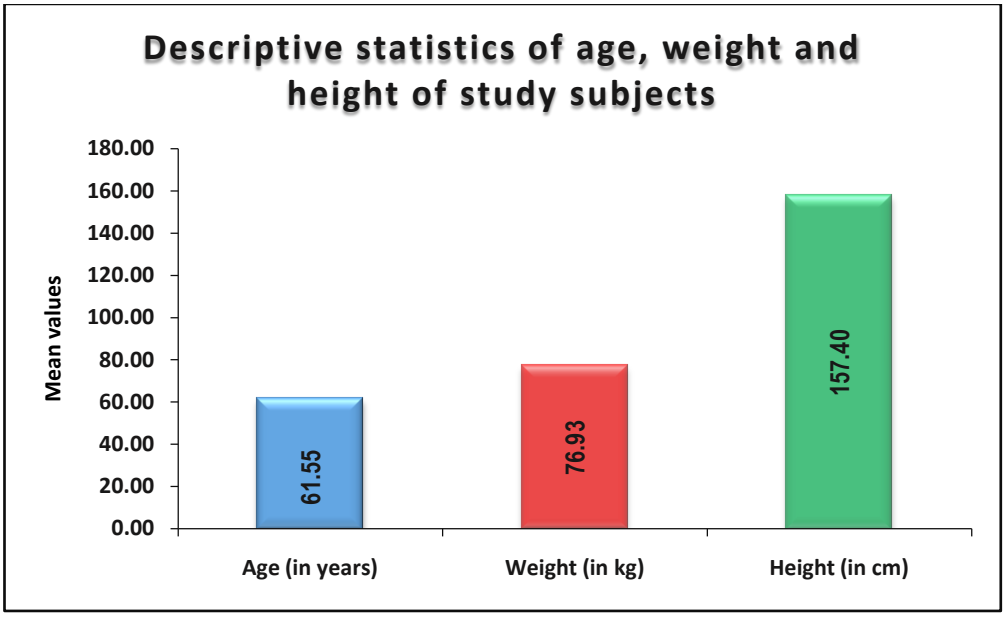


Figure 19.(1):-Descriptive statistics of age, weight and height of study subjects.

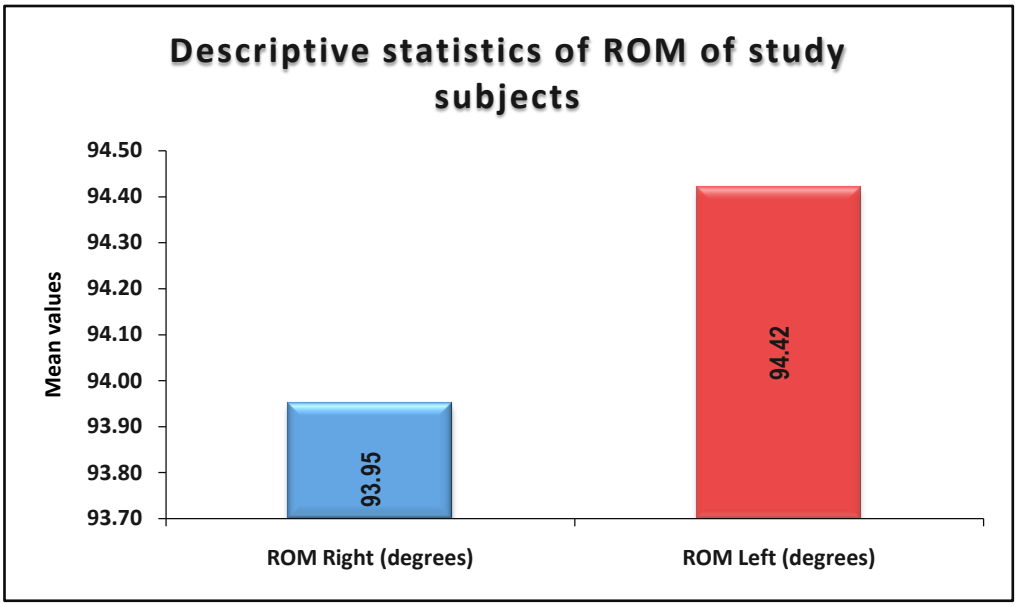


Figure 19.(2):-Descriptive statistics of ROM of study subjects.

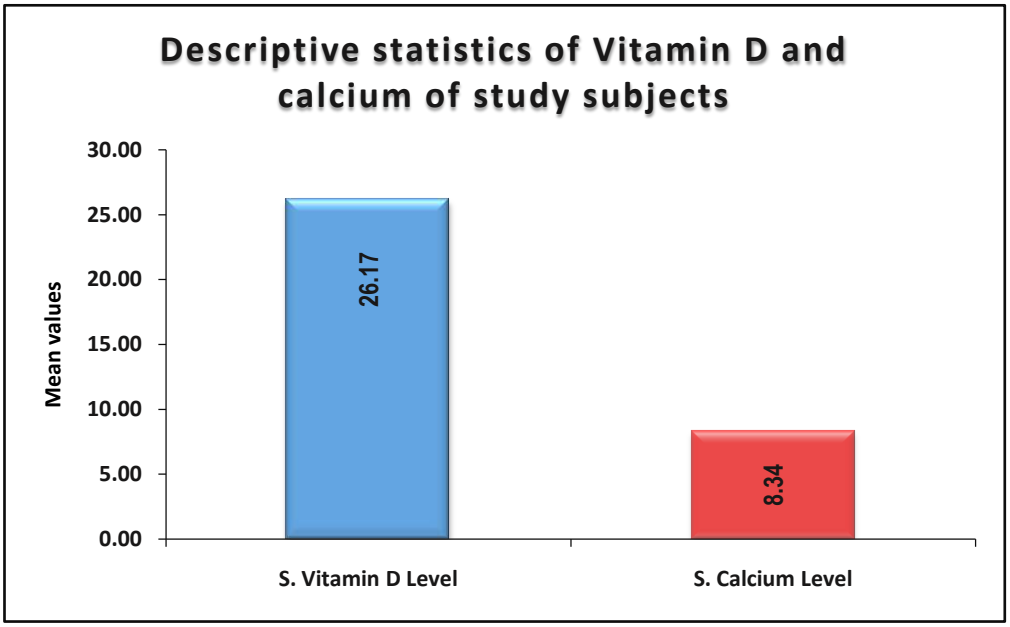


Figure 19.(3):-Descriptive statistics of Vitamin D and calcium of study subjects.

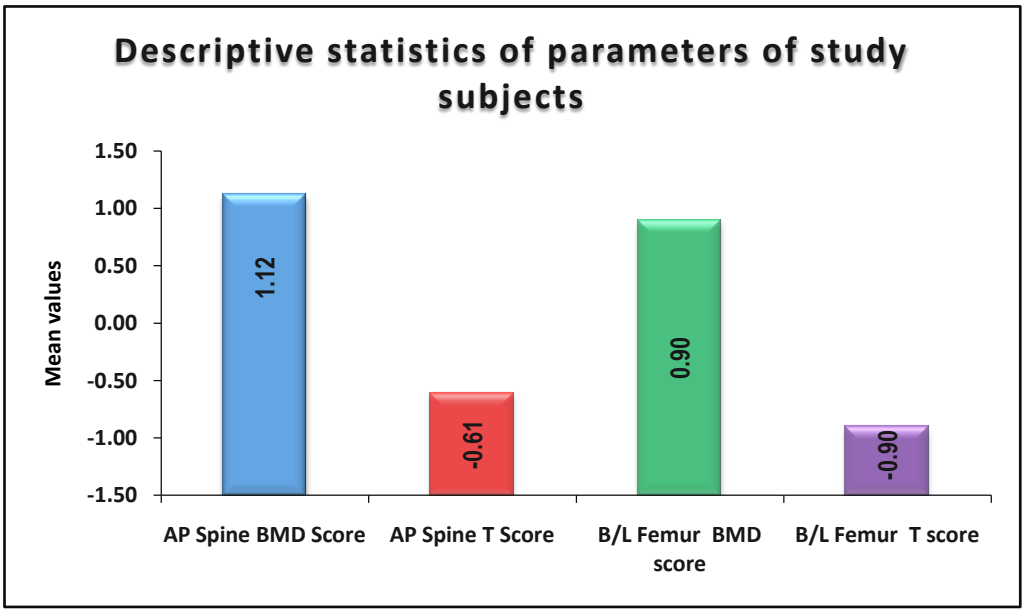


Figure 19.(4):-Descriptive statistics of BMD of study subjects.

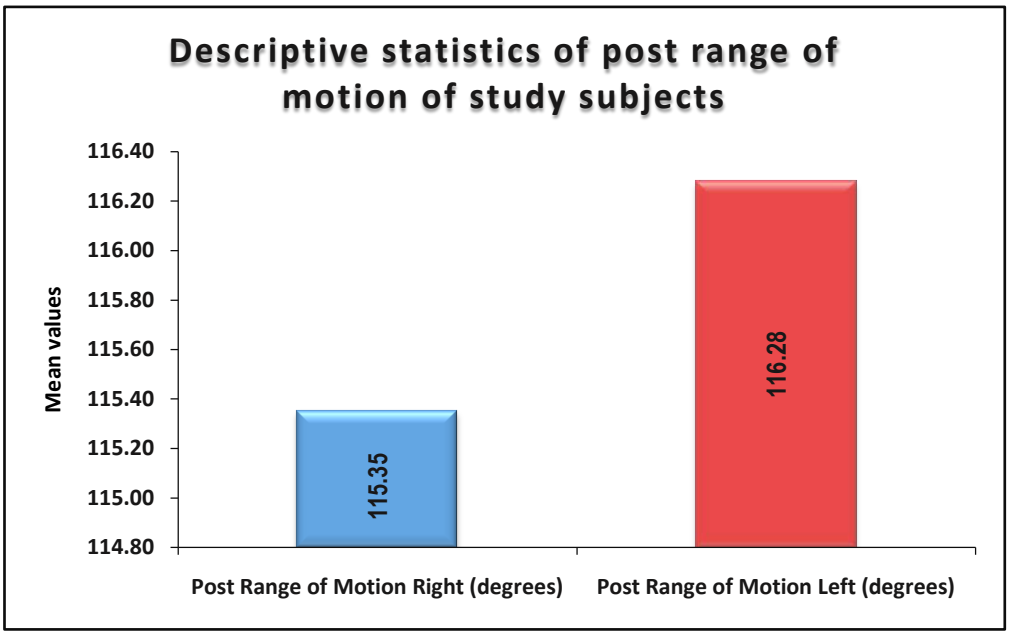


Figure 19.(5):-Descriptive statistics of post range of motion of study subjects.

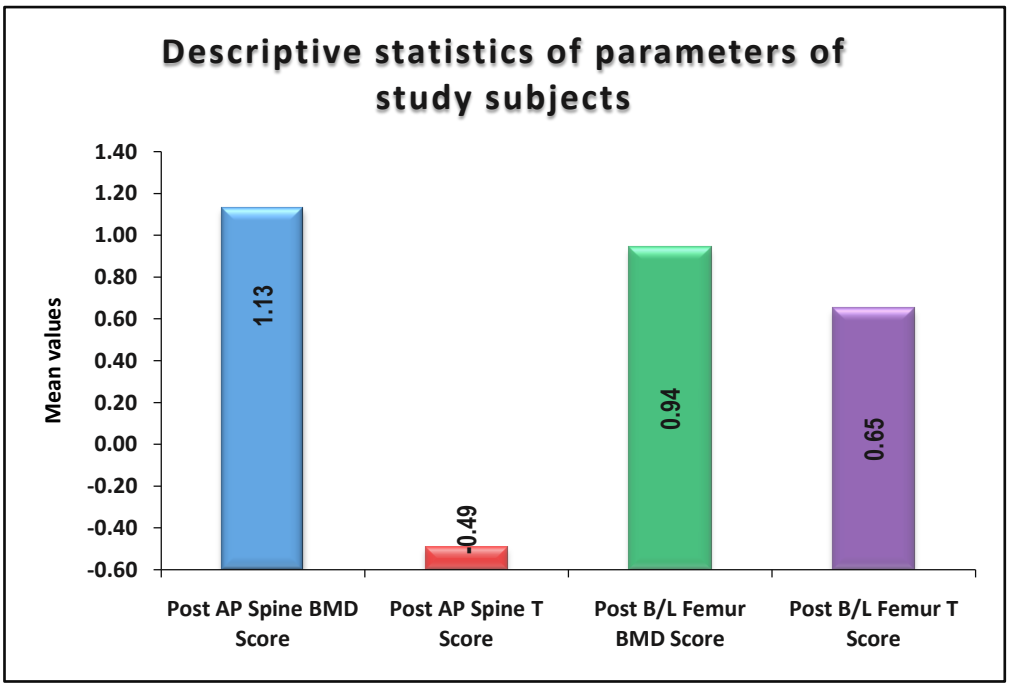


Figure 19.(6):-Descriptive statistics of post BMD score of study subjects.

Mean ± SD of age, weight and height of study subject was 61.55 ± 9.27, 76.93 ± 13.20 and 157.40 ± 9.07 respectively.

Mean ± SD of ROM right (degrees) and ROM left (degrees) of study subjects was 93.95 ± 5.41 and 94.42 ± 5.02 respectively.

Mean ± SD of S. vitamin D Level and S. calcium Level of study subjects was 26.17 ± 13.83 and 8.34 ± 0.91 respectively.

Mean ± SD of AP spine BMD score and AP spine T score of study subjects was 1.12 ± 0.19 and -0.61 ± 1.52 respectively.

Mean ± SD of B/L femur BMD score and B/L femur T score of study subjects was 0.90 ± 0.22 and -0.90 ± 1.26 respectively.

Mean ± SD of post range of motion right (degrees) and post range of motion left (degrees) of study subjects was 115.35 ± 8.82 and 116.28 ± 8.74 respectively.

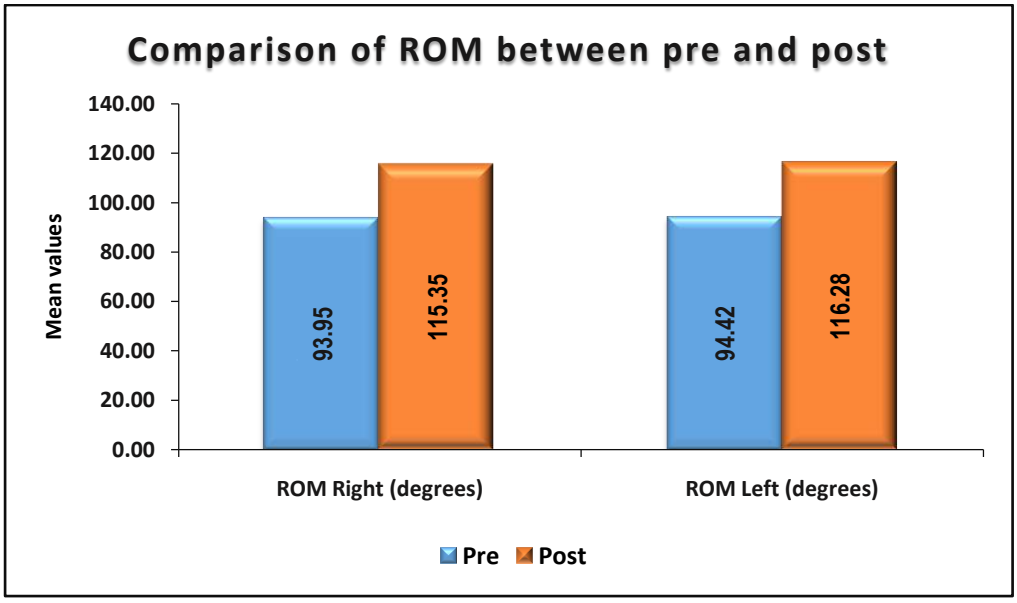
Mean ± SD of post AP Spine BMD Score and post AP Spine T score of study subjects was 1.13 ± 0.18 and -0.49 ± 1.47 respectively.

Mean ± SD of Post B/L femur BMD score and post B/L femur T score of study subjects was 0.94 ± 0.18 and -0.65 ± 1.30 respectively.It is shown in table 19, figure 19.1 to 19.6.

Table 20:-Comparison of ROM between pre and post.

Variables	Pre	Post	t	p-value	Difference
	Mean ± SD	Mean ± SD			Mean ± SD
ROM Right (degrees)	93.95 ± 5.41	115.35 ± 8.82	-13.530	<.0001	21.40 ± 10.37
ROM Left (degrees)	94.42 ± 5.02	116.28 ± 8.74	-14.596	<.0001	21.86 ± 9.82

Figure 20:-Comparison of ROM between pre and post.



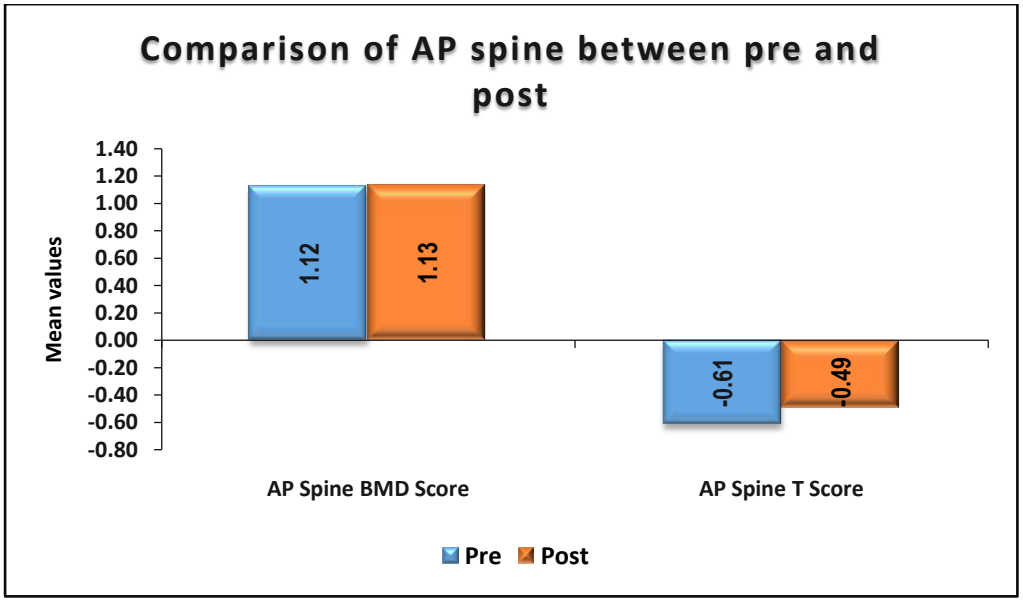
Mean ± SD of pre ROM right (degrees) (93.95 ± 5.41) was significantly increased to 115.35 ± 8.82 post operatively (p value<.0001).

Mean ± SD of pre ROM left (degrees) (94.42 ± 5.02) was significantly increased to 116.28 ± 8.74 post operatively. (p value <.0001). It is shown in table 20, figure 20.

Table 21:-Comparison of AP spine between pre and post.

Variables	Pre	Post	t	p-value	Difference
	Mean ± SD	Mean ± SD			Mean ± SD
AP Spine BMD Score	1.12 ± 0.19	1.13 ± 0.18	0.906	0.370	0.05 ± 0.33
AP Spine T Score	-0.61 ± 1.52	-0.49 ± 1.47	-0.986	0.330	-0.07 ± 0.46

Figure 21:-Comparison of AP spine between pre and post.



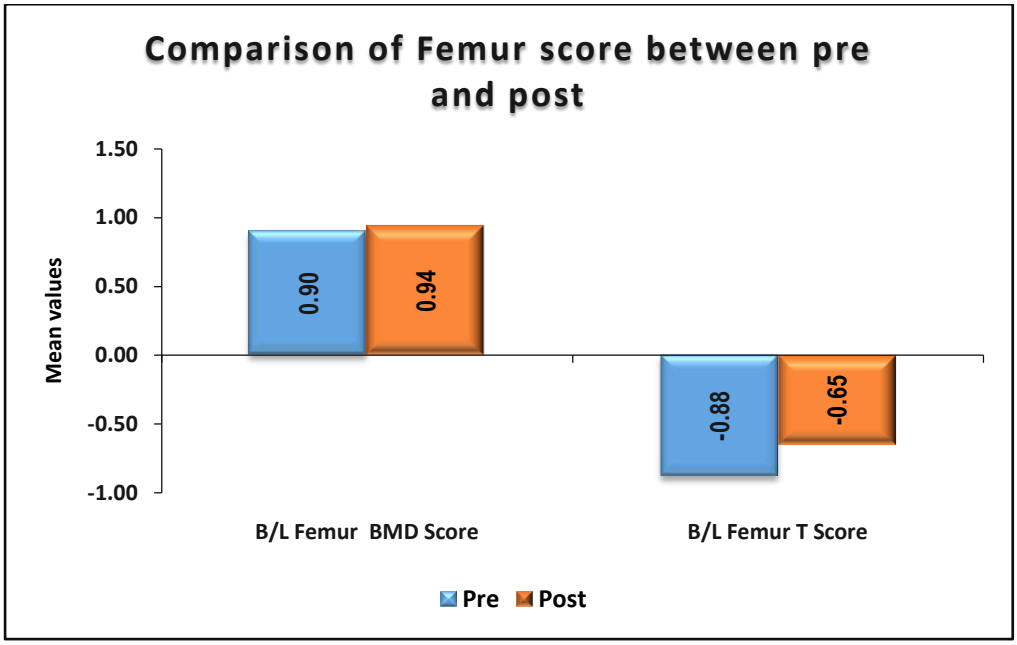
Mean ± SD of pre and post AP spine BMD score was comparable (1.12 ± 0.19vs 1.13 ± 0.18 respectively) (p value = 0.370).

Mean ± SD of pre and post AP spine T Score was comparable (-0.61 ± 1.52vs -0.49 ± 1.47 respectively) (p value = 0.330). It is shown in table 21, figure 21.

Table 22:-Comparison of Femur score between pre and post.

Variables	Pre	Post	t	p-value	Difference
	Mean ± SD	Mean ± SD			Mean ± SD
B/L Femur BMDscore	0.90 ± 0.22	0.94 ± 0.18	-2.049	0.047	-0.04 ± 0.13
B/L Femur T score	-0.88 ± 1.26	-0.65 ± 1.30	-2.299	0.027	-0.23 ± 0.66

Figure 22:-Comparison of Femur score between pre and post.



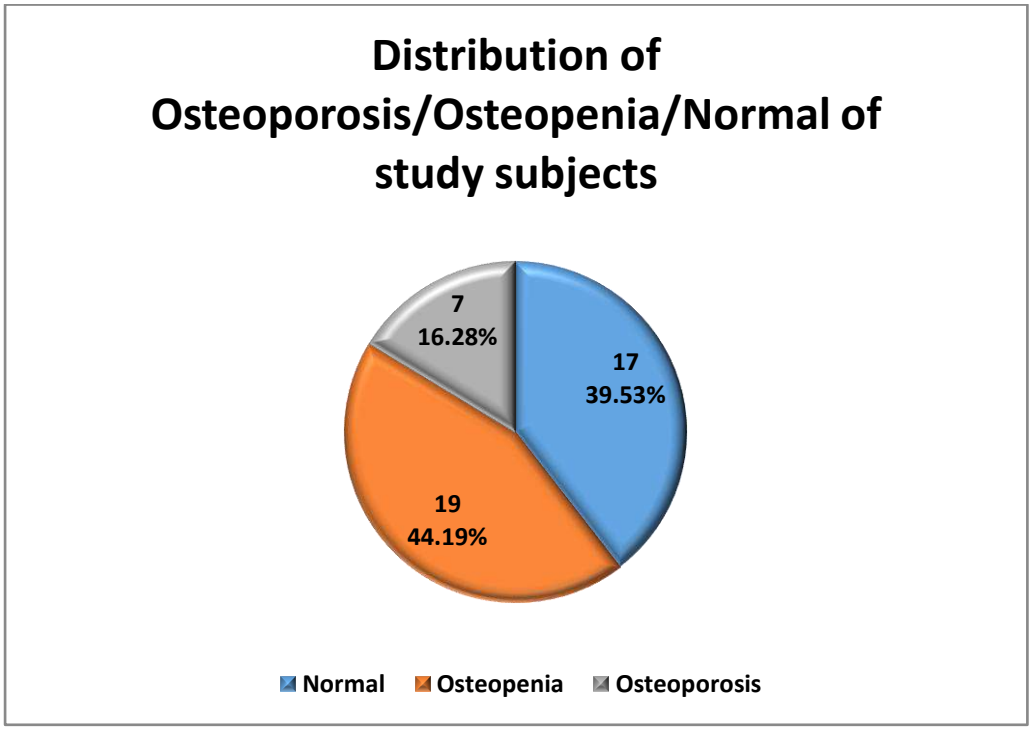
Mean ± SD of pre B/L femur BMD score (0.90 ± 0.22) was significantly increased to 0.94 ± 0.18 post operatively (p value = 0.047).

Mean ± SD of pre B/L femur T score (-0.88 ± 1.26) was significantly increased to -0.65 ± 1.30 post operatively (p value = 0.027).It is shown in table 22, figure 22.

Table 23:-Distribution of Osteoporosis/Osteopenia/Normalof study subjects.

Osteoporosis/Osteopenia/Normal	No. of cases	Percentage
Normal	17	39.53%
Osteopenia	19	44.19%
Osteoporosis	7	16.28%
Total	43	100.0%

Figure 23:-Distribution of Osteoporosis/Osteopenia/Normalof study subjects.



Majority of patients had Osteopenia (44.19%) followed by normal BMD (39.53%) and Osteoporosis (16.28%). It is shown in table 23, figure 23.

Discussion

The present study was a prospective Interventional Cohort study to determine the association of BMD in patients undergoing TKR in minimum 6 months follow up.

Total knee replacement (TKR) is an effective treatment for advanced knee arthritis providing significant pain relief and improved joint function.[82]Pain and length of recovery are the two main concerns in patients before going for total knee arthroplasty (TKA).[83,84] However its association with bone mineral density before and after the surgery has been studied less in the past.

We in our study found that there was a slight improvement in the BMD of femur post surgery but the spine BMD remained comparable to the per-op findings.

Demography and clinical characteristics

The study population was elderly with patients in their sixties or more. Majority of them were females (72.1%) who were mainly housewives. Among other studies, Soininvaara TA et al[6] included 69 patients with 20 males and 49 females; of mean age & (SD) being 67(8.2) years. Hahn MH et al[75] studied all (52) female patients of age >65; with average age of 70.2±3 years. Ishii Y et al[68] prospectively evaluated 24 consecutive patients (4 men, 20 women) with mean age 69 years (range, 60–83). Gazdzik TS et al[64] included 106 female patients with age 69.8(9.37) years. Dincel YM et al [97] studied a total of 76 patients (70 women, 6 men) with mean age of 65.67±7.70 (range: 51 to 84) years. By and large, previous literature shows elderly population undergoing TKR with female preponderance of the disease, which was in line with our study.

In our study, the duration of complaints was long since it is a chronic disease and patients waited for long time before undergoing surgery. In 44.2% patients, symptoms were present for around 5-10 years which included intermittent back pain with radiation to the leg which is mainly

because of nerve compression, non-mobility and increased resistance on movement.

All the patients who presented for TKR surgery had knee OA with bilateral surgery in 90.7% cases. Compared to our study, in study by Hahn MH et al[75] out of a total of 52 patients, unilateral TKA was done in 24 (46.2%) and there were 28 cases (53.8%) in which the patient received simultaneous bilateral knee surgery. Whereas, contrary to our study, Ishii Y et al[68] included 31 TKAs in which 7 bilateral surgeries were done. Soininvara TA et al[6] included sixty-nine patients who underwent unilateral TKA.

Outcomes

In view of the primary aim to understand the changes in BMD, all patients underwent DEXA scan which showed the BMD score and a standardised T score based on which it was known that 41.9% patients had normal BMD, 39.5% had osteopenia and 18.6% had osteoporosis. Among other studies, Dincel YM et al,[97] found in the preoperative period that out of total 76 patients, 19 had a normal BMD, 34 with a low BMD (osteopenia) and 23 with osteoporosis. In another study by Hahn MH et al[75] diagnosis of osteopenia was made in 32 (61.5) patients and osteoporosis in 20 (38.5).

Only 4% of the patients were osteoporotic in study, as judged by Soininvaara TA et al[6] with a T score below –2.5 in the total measurement area of both hips. The study also showed that the mean baseline BMD of the proximal femur on the affected side was significantly lower than that of the contralateral side. Preoperatively, 27% and 38% of the patients had total hip BMD Z-score more than 1 SD in the operated side and contralateral hips, respectively.

In the present study, Post-TKR, it was seen that the patients showed a significant improvement in the femur BMD score from 0.90 ± 0.22 to 0.94 ± 0.18 (p value = 0.047) with a femur T-score improvement from (-0.88 ± 1.26) to -0.65 ± 1.30 post operatively (p value = 0.027). The findings were in line with the study by Soininvaara TA et al[6] study, who

showed a significant improvement in the postoperative knee status and the physical activity of the patients (AKS score) after 1 year.

However, few of the studies though found an improvement in the BMD of femur post surgery, the values failed to reach statistical significance. Study by Dincel YM et al,[97] showed that the T and Z scores of the proximal femur showed a slightly improvement in the postoperative course (preoperative and postoperative T score was – 1.5763 and – 1.5513; Z score was – 0.0461 and – 0.0632), but the change was statistically insignificant ($p \geq 0.05$). In another study by Hahn MH et al,[75] there was no significant changes of femur neck, total hip BMD between preoperative and 1 year postoperative. One year BMD being 0.695±0.086 and 0.762±0.102 as compared to preoperative values of 0.694±0.082 and 0.755±0.099.

In study by Ishii et al,[68] despite a predicted age-related loss of 4% during 2 years, 45% of the hips on the operative side and 59% of the hips on the non-operative side had BMD higher than preoperative levels, the statistical significance of which was not shown.

Some studies have even found opposite results. In one of the study on 28 patients, with BMD measured around proximal tibia at 9 regions, the mean bone mineral density of all 9 regions of interest at the proximal tibia temporarily decreased by 13%.[72] Petersen et al[70] included all 25 primary arthritis knees, where BMD measured under the tibial component 6 regions observed that on average, the density for all regions of interest below the tibial component showed a significant and progressive decrease in BMD, reaching 22% at 3 years follow-up. In study by Hopkins et al,[69] with total of 48 patients, 28% of the controls had OA, and 86% of the testing group had OA, study concluded that following surgery, an immediate loss of ipsilateral bone mass at the TH was demonstrated which was not restored at 12 months. Kim et al[67] included 48 patients where BMD of both femoral neck, trochanter and total hip areas were significantly lower than preoperative BMD at one month and three months after TKA.

We believe that postoperatively, early decrease of BMD can occur with decreased activity and weight load due to postoperative pain, less recovery of general condition and nutritional state. Moreover, there is contribution by postoperative increased bone resorption. However, recovery of BMD may occur within 6 months to one year due to their restoration. Although, there must be some predicted rates of age related loss at postoperative one year, even then in our cases, increased mobility of patients after TKA has been suggested to increase femur BMD, Secondly, our study might have an inclusion bias possibility of more ambulating patients and patients who showed good results, who visited the hospital regularly, which might have led to significant improvements in 6 months.

As per our study results, the spine BMD score did not show a significant improvement (1.60 ± 3.07 in pre-op vs 1.13 ± 0.18 at 6 months respectively) (p value = 0.327). In the study by Dincel YM et al,[97] it was observed that that both the T and Z scores of the spine (L1-L4) showed a slightly positive trend, however, with an insignificant statistical difference ($p \geq 0.05$). Their observations, in concurrence to our results showed that patients who underwent TKA experienced a statistically insignificant bone gain at the spine at followup after the surgery.

However, contrary to our findings, Hahn MH et al[75] observed the spine BMD were increased in both the bisphosphonate treatment group and the non-treatment group (0.045 g/cm2 and 0.036 g/cm2).

One of the study by Beaupre et al.[71] showed a negative change in BMD values of the spine in the first postoperative year compared to the preoperative period.

Although, there are many studies about BMD changes regarding the periprosthetic region after total joint replacement, but studies about BMD changes of axial bone after total joint replacement in patients with OA are limited.

The spine BMD are valuable as its measurements denote the status of the bone density outside the implantation site. As chances of compression fractures in senile osteoporosis of the lumbar region are high and common, concerned area should be studied and comparison of pre-postoperative data should be recorded for further management.

Lastly, the study results were good in terms of significant improvement in the bilateral range of motion ($p<0.05$). Our findings were in line with the previous studies who showed efficacy in ROM improvement post-TKR.[6,68] In line with this we recommend early mobilisation and intervention for better restoration of BMD post-TKR.

Summary

The present study was a prospective Interventional Cohort Study conducted at the Department of Orthopaedics, Dayanand Medical College, Ludhiana. The study included admitted patients for elective total knee replacements who were analyzed under a period of 6 months to determine the association of BMD in patients undergoing TKR in the 6 months follow up.

Patients were assessed preoperatively using a proforma having two parts which were to be filled by the clinician and the patient respectively, BMD at the lumbar and hip region were measured by dual energy X-ray absorptiometry (DXA) with supine position. The bone density of the lumbar region (L1-L4), left femoral neck and left total hip density were measured. Postoperative BMD was measured by same machine and same way. Osteoporosis was defined by a T-score -2.5 or less and osteopenia was defined by a T-score -2.5 between -1 at the lumbar, femoral neck and total hip region whichever was lowest.

After TKR, the patients were again assessed for BMD and range of motion at 6 months follow up. The comparison of BMD was made between the pre-operative and post-operative 6 months values.

Statistically, the comparison of quantitative variables between the study groups was done using ANOVA. For comparing categorical data, Chi square ($\chi 2$) test was performed and exact test was used when the expected frequency was less than 5. A probability value (p value) less than 0.05 was considered statistically significant.

The salient results of the study were:

- The study population was elderly with mean age of 61.55 ± 9.27 years.
- Majority of them were females (72.1%) who were housewives.
- All the patients who presented for TKR surgery had knee OA with bilateral surgery in 90.7% cases.
- The duration of complaints was long since it is a chronic disease and patients may wait for long time before undergoing surgery.

In 44.2% patients, symptoms were present for around 5-10 years.

- The symptoms of knee OA in the study included intermittent back pain with radiation to the leg
- 41.9% patients had normal BMD, 39.5% had osteopenia and 18.6% had osteoporosis
- Post-TKR it was seen that the patients showed a significant improvement in the femur BMD score from 0.90 ± 0.22 to 0.94 ± 0.18 (p value = 0.047) with a femur T-score improvement from (-0.88 ± 1.26) to -0.65 ± 1.30 post operatively (p value = 0.027).
- Overall the spine BMD score did not show a significant improvement (1.60 ± 3.07 in pre-op vs 1.13 ± 0.18 at 6 months respectively) (p value = 0.327).
- Mean ± SD of pre ROM right (degrees) (93.95 ± 5.41) was significantly increased to 115.35 ± 8.82 post operatively (p value<.0001) and of pre ROM left (degrees) (94.42 ± 5.02) was significantly increased to 116.28 ± 8.74 post operatively. (p value <.0001). Overall, there was a significant improvement in the bilateral range of motion ($p<0.05$).

To sum up, our study showed promising results of TKR in terms of significant improvement in the bilateral range of motion and the femur BMD score which shows a better hope to patients needing TKR. Though there was a significant improvement in the BMD of spine post surgery but the spine BMD remained comparable to the per-op findings. In view of this, future studies with long-lasting and more frequent follow-ups are needed to understand the impact of post-TKR changes in BMD.

Conclusion

Our study showed promising results of TKR in terms of significant improvement in the bilateral range of motion and the femur BMD score which shows a better hope to patients needing TKR. The results are consistent with the theory that the increased mobility of patients after

TKR, leading to increased activity levels, may increase femur BMD. Thus, early TKR may be protective against later hip fractures by allowing increased range of motion and BMD.

However,it has been observed that osteoporosis or opsteopenia in most of the patients is not diagnosed preoperatively. So, patients should be evaluated pre operatively inorder to give appropriate treatment.

In our study,in view of the spine, BMD score did not show any significant improvement during the follow up of 6 months which needs to be corrected with optimal medication therapy post operatively. In view of this, future studies with long-lasting and more frequent follow-ups are needed to understand the impact of post-TKR changes in BMD.

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8. DAYANAND MEDICAL COLLEGE & HOSPITAL, LUDHIANA

Pro forma for Patients of Total Knee Replacement – Pre op

S.No. Date:

Name: Age:

Sex:

CR No.: Admission no.

Father/Husband Name: Occupation of Self:

TKA funded by: Self/ Insurance/ Empanelment/ Others

Weight: _____ kg Height: _____ cm BMI: _____

Diagnosis: OA / RA / Others Knee Involved: Right/Left/Bilateral

Date of proposed TKA: Side of proposed TKA: Right/ Left/ Bilateral

- Duration of complaints: > 10 y/ 5 – 10 y/ 2 – 5 y / 1 – 2 y/ ≤1 years prior to TKA/ Not sure

Parameter	Right (degrees)	Left (degrees)
Range of motion		
Alignment: Varus Valgus		

- Laxity Medio-lateral: $\leq 5^0$/ 6-9^0/ 10-14^0/ $\geq 15^0$
- History of low back pain: Yes/ No; If yes: Intermittent/ Regular, not severe/ severe
- History of radiating pain in leg: Yes/ No
- X-Rays Findings: Grade:
  (Kellgren and Lawrence classification of Osteoarthritis)
- S.VITAMIN D LEVELS :
- S.CALCIUM LEVELS

DAYANAND MEDICAL COLLEGE & HOSPITAL, LUDHIANA

Proforma for Patients of Total Knee Replacement – Post op

S.No. Date:

Name: Age:

Sex:

CR No.: Admission no.

Diagnosis: OA / RA / Others Knee Involved:

Right/Left/Bilateral

Date of TKA: Side of TKA: Right/ Left/ Bilateral

Implant used: Patella resurfacing: Yes/ No

- Duration of complaints: > 10 y/ 5 – 10 y/ 2 – 5 y / 1 – 2 y/ ≤1 years prior to TKA/ Not sure

Parameter	Right (degrees)	Left (degrees)
Range of motion		
Alignment: Varus Valgus		
Flexion contracture		
Extension Lag		

Laxity: AP: < 5mm/ 5-10 mm/>10 mmMedio-lateral: <5°/ 6°-9°/10°-14°/ ≥15°

- DEXA scan (BMD Score/T Score)

Signature of Candidate **Signature of Supervisor**

- ALP LEVELS :
- DEXA scan (BMD Score/T Score)
- OSTEOPORORSIS / OSTEOPENIC / NORMAL:

IF OSTEOPOROTIC , BISPHOSPHONATES GIVEN : YES / NO

BISPHOSPHONATE:

S. No.	Name	Age (in yrs)	MRD No.	Father/ Husband Name	Occupation of Self	Weight (in kg)	Height (in CM)	Diagnosis	Knee Involved	Date of Proposed TKA	Side of Proposed TKA	Duration of Complaints	Parameter			
													Range of Motion		Alignment Varus	
													Right (degrees)	Left (degrees)	Right (degrees)	Left (degrees)
1	Rameshwar Singh	70.5	22689	Gurpal singh	Agriculture	88	172	OA	bilateral	21.05.2019	left	5-10 Y	10-90°	10-100°	Varus	Varus
2	Ravinder Pal Kaur	51.7	769219	Ram singh	Housewife	75	147	OA	Bilateral	18.07.2019	Bilateral	1-2 Y	5-90°	5-90°	Varus	Varus
3	Harjinder Kaur	62.7	618942	gurdev singh	Housewife	75	156	OA	Bilateral	16.11.2018	Bilateral	>10 Y	10-100°	10-100°	Normal	Varus
4	Manjit Kaur	59.4	755844	Harnek Singh	Housewife	58	147	OA	Bilateral	27.06.2019	Bilateral	≤1	5-90°	10-100°	Varus	Varus
5	Baldev Singh	68.8	666560	Rajinder singh	Dependent	75	170	OA	bilateral	21.02.2019	left	5-10 Y	10-100°	10-100°	Normal	Varus
6	Sukhwinder Kaur	44.1	770754	Baljinder Singh	Housewife	97	155	OA	bilateral	20.07.2019	right	2-5 Y	5-90°	10-90°	Varus	Varus
7	Joginder Kaur	55	654434	Balraj singh	Housewife	98	162	OA	Bilateral	24.01.2019	Bilateral	5-10 Y	10-100°	10-90°	Normal	Varus
8	Sohan Singh	68.1	627300	Kishan singh	Dependent	50	160	OA	Bilateral	06.01.2019	Bilateral	>10 Y	10-100°	10-90°	Varus	Normal
9	Poonam Sethi	68	21695	Bishankar Dass	Housewife	66	150	OA	Bilateral	20.06.2019	Bilateral	1-2 Y	10-100°	10-100°	Normal	Varus
10	Rajvir Kaur	37.2	733272	Jaskran Singh	Housewife	51	135	OA	Bilateral	28.05.2019	Bilateral	5-10 Y	5-100°	5-90°	Varus	Normal
11	Sudesh Rani	60.4	739570	Narinder Pratap	Retired Govt. Jo	80	160	OA	bilateral	01.06.2019	left	2-5 Y	10-90°	20-100°	Normal	Varus
12	Ramti Raman	65.8	688934	Prabhu dev	Dependent	80	165	OA	bilateral	21.03.2019	left	≤1	10-100°	10-100°	Normal	Varus
13	Surinder Singh	60.2	687923	Harinder singh	Agriculture	88	162	OA	Bilateral	14.03.2019	Bilateral	5-10 Y	10-90°	5-100°	Varus	Varus
14	Gian Kaur	70.4	556415	Ajit Singh	Housewife	72	152	OA	Bilateral	08.06.2020	Bilateral	>10 Y	5-100°	10-100°	Varus	Normal
15	Kiranjit Rani	41.6	729824	mohan lal	Housewife	67	155	OA	Left	24.05.2019	Left	2-5 Y	10-90°	20-100°	Normal	Varus
16	Kulbir Kaur	52.6	796655	Balbir Singh	Housewife	76	147	OA	Bilateral	28.08.2019	Bilateral	5-10 Y	10-100°	10-90°	Normal	Varus
17	Baljit Kaur	67.3	739582	Gurkirpal Singh	Housewife	104	157	OA	Bilateral	01.06.2019	Bilateral	2-5 Y	5-90°	20-90°	Varus	Varus
18	Padma Rani	63.6	258621	Ramesh Kumar	Housewife	90	152	OA	Bilateral	04.06.2019	Bilateral	5-10 Y	10-90°	20-90°	Varus	Varus
19	Jaswant Kaur	78.5	738269	Joginder Singh	Housewife	80	151	OA	Bilateral	01.06.2019	Bilateral	>10 Y	10-100°	20-90°	Varus	Varus
20	Jaspal Kaur	55.9	741412	Sukhdev Singh	Housewife	90	156	OA	bilateral	04.06.2019	right	5-10 Y	10-90°	5-90°	N	Varus
21	Rajpal Kaur	55.4	689274	Inderjit Singh	Housewife	75	155	OA	bilateral	30.05.2019	right	5-10 Y	5-90°	10-100°	N	Varus
22	Shakuntala Sharma	69.9	749344	Dwarka Nath	Housewife	59	155	OA	bilateral	18.06.2019	left	>10 Y	10-90°	10-100°	Varus	Normal
23	Amarjit Kaur	63.1	8953	Kuldip Singh	Housewife	58	157	OA	Bilateral	21.02.2019	Bilateral	5-10 Y	20-100°	10-90°	Varus	Varus

S. No.	Name	Laxity Medio-lateral	History of low back pain	History of radiating pain in leg	X-Rays Findings K & L Grade	S. Vitamin D Level	S. Calcium Level	DEXA scan		Osteoporosis/ Osteopenia/ Normal
								AP Spine	B/L Femur	
								BMD Score/ T Score	BM Dscore/ T Score	
1	Rameshwar Singh	6-9°	No	Yes	III	38.6	9.4	1.391/1.8	1.320/1.5	Normal
2	Ravinder Pal Kaur	≤5°	No	Yes	III	29.6	9.27	1.063/-1.0	0.902/-1.0	Normal
3	Harjinder Kaur	10-14°	No	No	IV	18.42	8.4	1.053/-1.1	0.857/-1.2	Osteopenic
4	Manjit Kaur	≥15°	Regular, Not severe	Yes	III	19.86	9.2	0.959/-1.8	0.661/-2.7	Osteoprosis
5	Baldev Singh	10-14°	No	No	III	28.6	9.4	0.961/-2.2	0.833/-1.8	Osteopenic
6	Sukhwinder Kaur	6-9°	Intermittent	No	III	15.41	7.9	1.150/-0.2	1.043/0.0	Normal
7	Joginder Kaur	≤5°	Intermittent, Not severe	Yes	IV	40.7	9.5	1.074/-0.9	0.778/-1.8	Osteopenic
8	Sohan Singh	10-14°	No	Yes	III	12.21	8.4	1.041/-1.05	0.944/-1.1	Osteopenic
9	Poonam Sethi	10-14°	No	No	III	28.6	9.6	0.948/-1.9	0.657/-2.7	Oeteoprosis
10	Rajvir Kaur	≥15°	Intermittent	No	III	13.83	8.7	1.009/-1.4	0.890/-1.1	Osteopenic
11	Sudesh Rani	10-14°	Intermittent,	No	III	19.91	8.7	1.029/-1.3	0.798/-1.7	Osteopenic
12	Ramti Raman	6-9°	Regular	Yes	IV	12.9	5.4	1.196/-0.2	0.857/-1.6	Oseopenic
13	Surinder Singh	≤5°	Regular, Severe	No	IV	39.4	9.6	1.376/1.3	1.084/0.1	Normal
14	Gian Kaur	6-9°	No	No	II	18.63	10.1	0.854/-2.7	0.774/-1.9	Osteoprosis
15	Kiranjit Rani	10-14°	Regular, Severe	Yes	III	18.58	8	1.068/-0.9	10115/0.6	Normal
16	Kulbir Kaur	≤5°	No	Yes	III	17	6.9	1.219/0.3	0.773/-1.9	Osteopenic
17	Baljit Kaur	10-14°	Intermittent	Yes	IV	19.46	7.4	1.333/1.3	0.990/0.3	Normal
18	Padma Rani	≤5°	No	Yes	I	7.29	8.3	1.110/-0.6	0.687/-2.5	Osteopenic
19	Jaswant Kaur	≥15°	Intermittent, Not severe	No	IV	24.6	8.4	1.170/-0.1	0.856/-1.3	Osteopenic
20	Jaspal Kaur	6-9°	No	No	III	20.04	8.1	1.416/2.0	1.133/0.7	Normal
21	Rajpal Kaur	6-9°	Regular	Yes	IV	47.74	8.9	1.005/-1.5	0.801/-1.7	Osteopenic
22	Shakuntala Sharma	10-14°	No	No	III	48.83	8.4	0.766/-3.5	0.684/-2.5	Osteoprosis
23	Amarjit Kaur	≥15°	Regular	Yes	IV	39.66	7.9	1.143/-0.3	0.948/-0.6	Normal

S. No.	Name	Age (in yrs)	MRD No.	Father/ Husband Name	Occupation of Self	Weight (in kg)	Height (in CM)	Diagnosis	Knee Involved	Date of Proposed TKA	Side of Proposed TKA	Duration of Complaints	Parameter			
													Range of Motion		Alignment Varus	
													Right (degrees)	Left (degrees)	Right (degrees)	Left (degrees)
24	Shinder Singh	56.7	6T73515	Gurdeep Singh	Self	85	177	OA	Bilateral	19.02.2019	Bilateral	5-10 Y	5-90°	10-90°	Normal	Varus
25	Madhu Khera	59.6	716614	Ashok Kumar	Housewife	83	155	OA	Bilateral	27.04.2019	Bilateral	2-5 Y	10-100°	10-100°	Varus	Normal
26	Harpal Kaur	53.1	708899	Narinder Pal Brar	Housewife	70	156	OA	Bilateral	09.05.2019	Bilateral	>10 Y	5-100°	10-90°	Varus	Varus
27	Gian Kaur	80.9	636015	Sukhdev Singh	Housewife	72	152	OA	Bilateral	20.12.2018	Bilateral	>10 Y	15-90°	10-90°	Varus	Varus
28	Saroj Bala	60.6	754147	Ramesh kumar	Housewife	68	141	OA	bilateral	26.06.2019	left	5-10 Y	10-100°	10-100°	Varus	Varus
29	Kiran Bansal	55.3	689448	Subhash Bansal	Housewife	81	149	OA	bilateral	21.03.2019	left	5-10 Y	5-90°	10-100°	Varus	Varus
30	Manjit Kaur	61.3	718880	Balwinder	Housewife	64	163	OA	Bilateral	09.05.2019	Bilateral	5-10 Y	5-90°	10-90°	Varus	Varus
31	Mitter Sain Goyal	66	539992	Sehaj Ram	Business	80	157	OA	Bilateral	13.03.2019	Bilateral	2-5 Y	10-90°	5-90°	Varus	Varus
32	Raj Rani Thapar	56	611295	Harmesh Thapar	Housewife	95	165	OA	Bilateral	16.11.2018	Bilateral	>10 Y	10-80°	10-90°	Varus	Varus
33	Bhupinder Singh	73.7	549203	Gurpal singh	Dependent	87	169	OA	right	26.09.2018	right	>10 Y	15-90°	10-90°	Varus	Varus
34	Prem Lata	72.7	679837	Manoj	Housewife	90	155	OA	Bilateral	19.03.2019	Bilateral	>10 Y	20-90°	10-90°	Varus	Varus
35	Gurjit Kaur	57.3	747187	Swaraj singh	–	82	166	OA	Bilateral	17.06.2019	Bilateral	2-5 Y	10-100°	10-90°	Normal	Varus
36	Rajvinder Singh	65.2	591094	Ravi singh	Dependent	94	173	OA	Bilateral	29.09.2018	Bilateral	5-10 Y	10-90°	5-90°	Varus	Varus
37	Beant Kaur	54.4	582232	Harpal singh	Housewife	70	150	OA	bilateral	23.09.18	left	2-5 Y	5-100°	10-90°	Varus	Varus
38	Malkiat Kaur	70.9	644801	Manjeet singh	Housewife	75	156	OA	Bilateral	29.12.2018	Bilateral	5-10 Y	10-90°	5-100°	Varus	Varus
39	Rajinder Kaur	65	837992	Surjeet singh	Housewife	65	157	OA	bilateral	31.10.2019	left	5-10 Y	10-90°	10-100°	Varus	Varus
40	Jagvir Singh	54	724465	Yogesh raj	Dependent	95	175	OA	bilateral	09.05.2019	left	2-5 Y	10-100°	10-90°	Varus	Normal
41	Kuldip Kaur	63	833729	Hardeep singh	Housewife	57	146	OA	Bilateral	22.10.2019	Bilateral	5-10 Y	10-100°	10-100°	Varus	Varus
42	German Singh	75.3	731911	Sampuran Singh	Dependent	78	170	OA	Bilateral	25.05.2019	Bilateral	5-10 Y	15-90°	10-90°	Varus	Varus
43	Gurdev Kaur	55.4	833788	Gurpreet singh	Housewife	65	158	OA	Bilateral	27.10.2019	Bilateral	2-5 Y	10-90°	10-100°	Varus	Varus

S. No.	Name	Laxity Medio-lateral	History of low back pain	History of radiating pain in leg	X-Rays Findings K & L Grade	S. Vitamin D Level	S. Calcium Level	DEXA scan		Osteoporosis/ Osteopenia/ Normal
								AP Spine	B/L Femur	
								BMD Score/ T Score	BM Dscore/ T Score	
24	Shinder Singh	≤5°	Intermittent, Not severe	No	III	26.9	8.4	1.193/-0.2	1.007/-0.5	Normal
25	Madhu Khera	6-9°	No	No	III	37.87	8.4	1.085/-0.8	1.028/-0.1	Normal
26	Harpal Kaur	6-9°	No	No	III	13.76	7.5	0.948/-1.9	0.990/0.3	Osteopenic
27	Gian Kaur	6-9°	Intermittent,	Yes	IV	24.32	8.3	1.075/-0.9	0.761/-2.0	Osteopenic
28	Saroj Bala	6-9°	No	No	III	18.4	7.9	0.973/-1.7	0.861/-1.3	Osteopenic
29	Kiran Bansal	≤5°	Intermittent, Not severe	No	III	17.28	8.3	1.332/1.2	0.991/-0.3	Normal
30	Manjit Kaur	≤5°	Inetrmittent,	No	III	10.76	8.2	1.149/-0.3	0.017/-1.6	Osteopenic
31	Mitter Sain Goyal	≤5°	Intermittent, Not severe	No	III	38.05	7.9	1.266/0.4	0.889/-1.4	Osteopenic
32	Raj Rani Thapar	6-9°	Intermittent, Not severe	Yes	IV	29.42	9.1	1.173/-0.1	0.911/-0.8	Normal
33	Bhupinder Singh	6-9°	Intermittent, Not severe	Yes	IV	28.3	8.3	1.503/2.4	1.320/1.5	Normal
34	Prem Lata	6-9°	Intermittent, Not severe	Yes	IV	32.6	7.4	1.094/-0.7	0.857/-1.3	Osteopenic
35	Gurjit Kaur	≤5°	No	No	III	12.49	8.9	1.391/1.8	1.107/0.8	Normal
36	Rajvinder Singh	≤5°	Intermittent, Not severe	No	III	81.97	9.7	1.297/0.6	1.112/0.1	Normal
37	Beant Kaur	≤5°	Intermittent, Not severe	No	III	39.82	8.3	1.244/0.5	1.181/1.4	Normal
38	Malkiat Kaur	≤5°	Intermittent	No	IV	24.2	7.6	1.347/1.4	0.99/-0.1	Normal
39	Rajinder Kaur	6-9°	Intermittent, Not severe	No	III	–	–	0.827/-2.9	0.765/-2.0	Osteoprosis
40	Jagvir Singh	≤5°	Intermittent	No	III	18.46	6.42	0.949/-2.3	0.723/-2.7	Osteoprosis
41	Kuldip Kaur	6-9°	Intermittent, not severe	No	III	26.4	7.3	0.799/-3.2	0.714/-2.3	Osteoprosis
42	German Singh	≤5°	Intermittent, not severe	No	III	9.71	8.2	1.284/0	1.284/1.6	Normal
43	Gurdev Kaur	≤5°	No	No	III	28.4	8.4	0.714/-3.7	0.717/-2.3	Osteoprosis

EVALUATION OF BONE MINERAL DENSITY SCORE IN PATIENTS UNDERGOING TOTAL KNEE REPLACEMENT

THESIS PROPOSAL

FOR APPROVAL OF SUBJECT OF THESIS TO BE SUBMITTED

IN PARTIAL FULFILMENT OF THE REQUIREMENTS

FOR THE DEGREE OF

MASTER OF SURGERY

IN

ORTHOPAEDICS

OF THE

BABA FARID UNIVERSITY OF HEALTH SCIENCES

FARIDKOT

OCTOBER, 2018

DR. AAMNA ATHWAL

DEPARTMENT OF ORTHOPAEDICS
DAYANAND MEDICAL COLLEGE & HOSPITAL
LUDHIANA

ABSTRACT OF PLAN OF THESIS

Title	Evaluation of bone mineral density score in patients undergoing Total knee replacement
For the degree of	MS ORTHOPAEDICS
Name of the candidate	DR. Aamna Athwal
Supervisor	DR. PANKAJ MAHINDRA, Associate Professor Department of Orthopedics, DMCH, Ludhiana
Co-supervisor	DR. RAJNISH GARG, Professor and Head Department of Orthopedics, DMCH, Ludhiana DR. PARMINDER SINGH, Professor and Head Department of Endocrinology,DMCH, Ludhiana
Institution	Dayanand Medical College & Hospital, Ludhiana
University	Baba Farid University of Health Sciences, Faridkot

ntroduction:-Two of the predominant pathological disorders that affect bone mineral density are osteoporosis and osteoarthritis which decreases mobility of the body and ultimately bone mineral density leading to increase fracture risk.

Aims & objectives:-

1 To understand impact of total knee arthroplasties on bone mineral density of hip and spine after increase in mobilization of normal / osteopenic patients.
2 To see impact of bone mineral density in osteoporotic patients after TKR and after starting bisphosphonates.

Material & Methods:-Admitted patients for elective total knee replacement to be analysed under a period o\ 6 months at department of orthopedics, Dayanand medical college.

Pre operatively patient will be assessed using Performa to be filled by clinician and patient respectively and western Ontario and Mcmaster Universities osteoarthritis Index (WOMAC) score,bone mineral density at lumbar and hip region to be measured by by dual energy xray absorpiometry (DEXA scan) and serum calcium , ALP and vitamin D3 levels.

Patient will be reassessed at a minimum period of 6 months after total knee arthroplasties and evaluate for change in bone mineral density scores.

Clinical Significance:-

Detection of patients with osteoporosis and decrease fracture risk. And improvement in overall mobility of patient after total knee replacement.

Keywords:- bone mineral density, total knee arthroplasty

Candidates Sign	Co-Supervisor Sign	Co-Supervisor Sign	tsupervisor Sign	Principal Sign

CERTIFICATE OF FACILITIES AVAILABLE

This is to certify that the facilities for work on the subject of thesis titled **'Evaluation of bone mineral density score in patients undergoing** Total knee replacement' exist in the Department of Orthopaedics, DMC&H, Ludhiana, and will be provided to the candidate. We will see that the data being included in the thesis are genuine and is collected by the candidate himself/herself under our superv'ision and guidance.

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APPROVAL PROFORMA
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Department	ORTHOPAEDICS
Topic of Thesis	EVALUATION OF BONE MINERAL DENSITY SCORE IN PATIENTS UNDERGOING TOTAL KNEE REPLACEMENT.
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Signature of Members of Research Committee with Stamp	Signature of Members of Ethics Committee with Stamp
1. HOD Pharmacology	1. HOD Physiology
2. HOD Surgery z 1	2. HOD Pathology
3. HOD Pathology	3. HOD Pharmacology
4. HOD Medicine	4. HOD SPM
5. Dean Academics	5. HOD Medicine
6. Vice Principal	6. HOD Surgery /
	7. HOD Obst. &Gynae
	8. Legal Expert
	9. Dean Academics
	10. Secretary, IEC
	11. Vice Principal
	12. Principal

Approved: Yes / No

Chair erson
Research Committees

Approved: Yes / No

anairperson
Ethics Committee
Chairperson

BABA FARID UNIVERSITY OF HEALTH SCIENCES, FARIDKOT

PROFORMA FOR REGISTRATION OF SUBJECT FOR DISSERTATION

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3	COURSE OF STUDY AMD SUBJECT	MASTERS OF SURGERY, ORTHOPAEDICS
4	DATE OF ADMISSION OF COURSE	10TH MAY, 2018
5	TITLE OF THE TOPIC	EVALUATION OF BONE MINERAL DENSITY SCORE IN PATIENTS UNDERGOING TOTAL KNEE REPLACEMENT.

6. BIRIEF **RESUME OF** THE **INTENDED WORK**

NEED FOR STUDY

The link between low BMD leading to grater fracture risk is well established in literature, what is not fully understood is the impact of TKR on BMD levels. This literature review attempts to answer this question. Total knee replacement (TKR) has revolutionized the care of patients with end-stage knee arthritis with the study, we would want to compare BMD in Normal, Osteoporotic and Osteopenic patients by DEXA scan and then starting Bisph‹›sphonates in patients with Osteoporosis & +/- in Osteopenic patients and then comparing the results after 6 months.

Osteoporosis and osteoarthritis is a common disease in women over the age of 65 and recent increase of aging population has increased the number of patients as well as the surgical management cases of both diseases. Because the main risk factors of Osteoporosis are aging and low body weight while those main risk factors of knee osteoarthritis are aging and obesity, these diseases have been considered as having inverse relationship. However, there are lots of patients who have both disease entities. In particular, in the case of patients with severe knee OA, gait disturbance due to pain and reduced activity in the living environment and poor exercise capacity make the bone mineral density of the hip and equal or even decrease. The studies about change of axial BMD in patient wlno underwent total knee anthroplasty due to severe OA are few and the absence of a consistent consensus. So we measure the BMD changes of HU' and SPINE in patients receiving total knee replacement due to severe degenerative OA and identify the clinical correlation factors such as postoperative bisphosphonate medication, whether

bilateral operation, the operatic›ns obesity status, preoperative knee function score or preoperative diagnosis of Osteoporosis.

Two of the predominant pathological disorders that affect bone mineral density (BMD) are osteoarthritis (OA) and osteoporosis (OP). Due to the destructive nature of OA on the joints and the resulting loss of mobility and function, surgery is a primary optton and as such OA accounts for between 80-90% of all total knee replacement (TKR/arthroplasty) procedures.

The relationship between OA and OP is complex and has been reported to be an inverse one, with OA being reported to increase BMD and thus it might be assumed to increase fracture protection. With such a high percentage of cases of TKR due to OA it could be concluded that this protective effect would reduce fracture risk in TKR patients due to having higher BMD, but increased fracture rates have also been reported in OA. A narrative literature review was conducted to investigate the links between BMD, OA, and fracture risk in TKR; these specific key terms were searched in different combinations across the databases.

REVIEW OF LITERATURE

Patients with OA of knee joint•›, in most cases, have relatively higher BMD. OA and osteoporosis have been recognized as inverse relationship to each other because the main risk factors of osteoporosis are aging and low body weight while those of knee OA are aging and obesity.![1,2] However, depending on the patient's age, lifestyle and environments, both diseases may be present simultaneously, especially in cases with long term disability due to OA.[3]

Hannan et al.[4] reported mean femoral BMD at the proximal femur sites with lower grades of knee OA to be 5-9% high also compared to those with no knee OA and mean femoral BMD in those with grade 4 OA was not higher than in those with no OA. The authors checked both side hip BMD of patient with severe OA and reported that patients had a lower hip BMD on the symptomatic knee side compared with that of the contralateral hip and hip BMD was positively correlatecl with grade of radiographic change and negatively correlated with knee functional score.[5]

Lingard et al." investigated the prevalence of osteoporosis in patients with severe hip and knee OA awaiting joint arthroplasty and reported that the overall rate of osteoporosis was 23% and 43% of patients would have been classified as osteopenia. In our study, there were 32 cases (61.5%) of patients having low bone densitt/, and 20 cases of patients diagnosed with osteoporosis. Labuda et al.[7] reported that osteoporosis is common in the osteoarthritic arthroplasty population, with a prevalence at least equal to that in the general population and suggested that osteoporosis assessment is needed in patients undergoing a joint replacement. There are many studies

about BMD changes regarding the periprosthetic region after total joint replacement, but studies aboul BMD changes of axial bone after total joint replacement in patients with OA are limited.

Gazdzik et al. ”’ reported that a decrease in BMD was observed in all determined regions within one year after the surgery and the most significant BMD decrease at the periprc›sthetic region was observed in the period between 5-12 weeks after the knee joint arthroplasty, the result furthermore shows increased bone resorption and decreased motor activity of the patients. So they recommended early pal:ient rehabilitation and loading of the operated extremity.

lshii et al.”’ investigated the relationship between TKR and BMD in the same and opposite hips and reported that there was no statistical difference among preoperative, 6 months, 1 year, 2 years after TKR and 45% of the hips on the operative side and 59% of the hips on the non-operative side at 2 years after TKR had higher BMD than preoperative levels.

However, Soininvaara et al.’[10]’ checked the BMD in the proximal femur and contralateral knee at one year after TKR and reported neither the hip nor the non-operated knee BMDs increased and concluded that improved mobility after TKR does not improve the effects of preoperative disuse ated with bone loss in the short term. However, in our study, the spine BMD was increased and hip BMD was decreased in non-treatment group at 1 year after TKR. Studies concerning the relationship between OA and fractures by Bergink et aI.’[11]! investigated the association between prevalent radiographic OA of the knee and incident vertebral and non-vertebral fracture and reported that the

knee OA is associated with an increased risk of in cidental vertebral and non-vertebral fracture, independent of BMD and parameters of postural stability.

Arden et al.[12] reported prevalent knee pain was associated with an increased risk of falling (hazard ratio [HRj 1.26. 95% confidence interval [CI] 1.17-1.36) and hip fracture (HR 2.0 95% CI 1.18-3.37). And they suggested knee pain and OA should be regarded as independent risk factors for fracture.

Joshi et al.[13] reported 4 cases of ipsilateral fracture of the femoral neck after TKR. They explained possible mechanisms of fractures are due to changes in the weight bearing axis of the extremity and poor mobility and weakened bones. So they suggested graduating weight bearing, treating osteoporosis and using less constrained devices may avoid stress fracture of the femoral neck after TKR.

Prieto Alhambra et al.[14] investigated changes of hip fracture rate before and after TKR due to OA and reported hip fracture rates were insignificantly reduced before the operation but, in the year after TKR, relative risk increased significantly up to 1.58 and then declined to equal by 3 years compared with controls. Recently, bisphosphonate are being prescribed as first choice drug for osteoporosis. And common mechanisms of failure of TKR are represented by aseptic loosening, infection, and instability. Biologic mechanisms related aseptic loosening are large amount of activated macrophages, high concentration of specific cytokines, and presence of bone resorption by osteoclasts.[15] Carulli et al.[16] proposed the use of bisphosphonate in patients undergoing a joint arthroplasty to reduce the progressive bone loss at the counterface between components and bone, to improve implant survival, and to prevent loosening. Hence, bisphosphonate treatment after TKR not only

helps strengthen the osteoporotic bone but it also prevents aseptic loosening of im Plants.

Wang et al.'[1] evaluated the long term effects of bisphosphonate on peripi osthetic BMD changes after TKR. They reported BMD increased at six and 12 months after TKR but no significant difference was noted after thirty-six months.

Lee et al.'[1] reported that BM(3 declined in more than half of the patients, even though they took the bisphosphonate treatment for only 1 year after TKR, this decline was significant in bilateral TKR patients. Moreover patients undergoing bilateral TKR, who load more severe OA at baseline had a lower BMD response after 2 years of bisphosphonate treatment, compared with patients with less severe unilateral knee OA who underwent unilateral TKR.'[1]" However, In our study, in bisphosphonate treatment group, total hip BMD was significantly increased compared to non-treatment group regardless of operation sites whether unilateral or bilateral and osteoporosis diagnosis.

Prieto--AIhambra et at.'*[0]' assessed the effect of bisphosphonate use on post TKR fracture risk and reported that the HR associated with bisphosphonate therapy after TKR was 0.5 in non-fractured patients previously and 0.45 in subjects with osteoporotic and with other previous fracture. This suggested bisphosphonate treatment after 1"KR reduced the risk of fracture by 50-55%.

AIMS AND OBJECTIVES OF THE STUDY

- To fully understand the irripact of total knee replacements/revisions or ai1hroplasties on BMD level/s. Based on the available evidence total knee replacements/revisions and arthroplasties increase BMD and thus decrease fracture risk. -Fhis review also addresses the possible implications of this research and possible options to reduce this risk.
- There are few reports on t›one mineral density (BMD) changes of axial bones after total knee replacement (TKR) due to severe osteoarthritis (OA) of the knee joint and its results are controversial and not much pronounced in indian population.

7. MATERIALS AND METHODS

SOURCE OF DATA

Admitted patients for elective total knee replacements. Analyzed under a period of 6 months at the Department of Orthopaedics, Dayanand Medical College, Ludhiana.

METHOD OF COLLEC?TION OF DATA

INCLUSION CRITERIA

- Undergoing primary TKR for knee arthritis.

EXCLUSION CRITERIA

- Patients undergoing reviE.ion knee replacement.

METHODOLOGY

Patients will be assessed pre-operatively using a proforma having two parts- to be filled by the clinician and the patient respectively and BMD at the lumbar and hip region were measured by dual energy X-ray absorptiometry (DXA,i with supine position. The bone density of the lumbar region (L1-L4), left femoral neck and left total hip density were measured. Postoperative BMD was measured by same machines and same way. Osteoporosis is defined by a T-score -2.5 or less and osteopenia is defined by a T-score -2.5 between -1 at the lumbar, femoral neck and total hip region whichever is lowest according to the World Health Organization (WHO) international reference standard. Patients will be re-assessed at a minimum of six months follow-up period using a Performa having two pails- to be filled by the clinician and the patient respectively and BMD score.

STA1”ISTICAL ANALYSIS

Data will be described in terms of range; mean +standard deviation (+ SD), median, frequencies (number of cases) and relative frequencies (percentages) as appropriate. t?omparison of quantitative variables between the study groups was done using ANOVA. For comparing categorical data, Chi square (y2) test will be peiformed and exact test will be used when the expected frequency is less than 5. A probability value (p value) less than 0.05 will be considered statistically significant. All statistical calculations will be done using SPSS (Statistical Package for the Social Science) SPSS 21 version statistical program for Microsoft Windows.

DOES THE STUDY REQUIRE ANY INVESTIGATIONS OR **INTERVENTIONS TO BE CONDUCTED ON PATIENTS OR OTHER** HUMANS OR ANIMALS’? **IF SO, PLEASE DESCRIBE BRIEFLY.**

Yes, DEXA scan preoperatively & after 6 months.

HAS ETHICAL **CLEARENCE BEEN OBTAINED** FROM YOUR INSTITUTION IN CASE CF 7.3?

Yes, attached herewith.

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DAYANAND MEDICAL **COLLEGE &** HOSPITAL, **LUDHIANA**

Pro forma for Patients of Total Knee Replacement - Pre op

S.No. Date:

Nam+: Age:

Sex:

CR No.: Admission no.

Father/Husband Name: Occupation of Self:

TKA flJnded by: Self/ Insurance/ Empanelment/ Others

Weight:____kg Height:_____cm BMI: ____

Diagnosis: OA / RA / Others Knee Involved: Right/Left/Bilateral

Date of proposed TKA: Side of proposed TKA: Right/ Left/ Bilateral

- Duration of complaints: > 1() y/ 5 — 10 y/ 2 - 5 y / 1 - 2 y/ s1 years prior to TKA/ Not sure

Parameter	Ftight (degrees)	Left (degrees)
Range of motion		
Alignment: Varus Valgus		
Flexion contracture		
Extension Lag		

- Laxity Medio-lateral: 5^0/ 6-9^0/ 10-14^0/ a15^0
- History of low back pain: Yes./ No; If yes: Intermittent/ Regular, not severe/ severe

Signature of Candidate Signature of Supervisor

- History of radiating pain in leg: Yes/ No
- X-Rays Findings: Grade: (Kellgren and Lawrence classification of Osteoarthritis)
- DEXA scan (BMD Score/T Score)
- Associated Ailments:

Hypei1ension: Yes/ No, since years, Regular treatment: Yes/ No

Diabetes Mellitus: Yes/ No, since years, Regular treatment: Yes/ No

Coronary Artery Disease: Yes/ No, since years, Regular treatment: Yes/ No

Other:

Current Medication:

Signature of Candidate

Signature of Supervisor

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Proforma for Patients of Total Knee Replacement - Post op

S.No. Date:

Name: Age:

Sex:

CR No.: Admission no.

Diagnosis: OA / RA / Others Knee Involved:

Right/Left/Bilateral

Date of TKA: Side of TKA: Right/ Left/ Bilateral

Implant used: Patella resurfacing: Yes/ No

- Duration of complaints: > 10 y/ 5 — 10 y/ 2 — 5 y / 1 - 2 y/ s1 years prior to TKA/ Not sure

Parameter	Right (degrees)	Left (degrees)
Range of motion		
Alignment: Varus Valgus		
Flexion contracture		
Extensi‹›n Lag		

Laxity: AP: < Smm/ 5-10 mmf>10 mmMedio-lateral: <5°/ 6°-9°/10°-14°/ a15°

- DEXA scan (BMD Score/T Sc‹»re)

Signature of Candidate **Signature of Supervisor**

CERTIFICATE OF I3EPARTMENTAL CLEARANCE

This is to certify that the plan c›f thesis entitled 'Evaluation of bone mineral density score in patients un‹Jergoing Total knee replacement' has been discussed in the Department of' ORTHOPAEDICS and approved by whole of the faculty of the department. The plan writing is satisfactory.

Supervisor

DR. P MAHINDRA
Associate Professor
Department of Orthopaedics
DMC&H, Ludhiana

Co-supervisor

DR. RAJNISH GARG
Professor and head
Department of Orthopaedics
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DMC&H, Ludhiana

DAYANAND MEDICAL COLLEGE & HOSPITAL

LUDHIANA

Ref. No: DMCH/ Dated: ‘‘

TO WHOM IT MAY CONCERN

Certified that the study ” involves only such investigations and / or treatment, which are relevant in the man‹zgement of patients and has no extra cost implications to the patient.

Name of candidate:	DR. AAMNA ATHWAL
Supen/isor:	DR. PANKAJ MAHINDRA
Co-Supervisor	DR.RAJNISH GARG
	DR.PARMINDER SINGH

Signature of candidate

Sianature of Su ervisor

DAYANAND MEDICAL COLLEGE & HOSPITAL,
LUDHIANA

Ref.No. DMCH/ Dated: 30/12/18

TO WHOM IT MAY CONCERN

I shall carry out the study 'Evaluation of bone mineral density score in patients undergoing Total knee replacement' meticulously and shall maintain the records for 5 year!s after the submission of thesis and present them to any competent authority as and when required. The following docurrients will be preserved:

1. List of enrolled patients› with identification details
2. Consent forms of all thnn enrolled patients
3. Proforma of each patient with verifiable details, individually signed by supervisor.

Dr. A m a Athwal
Resident G
Dept. of O hopaedics
DMC & Hospital, Ludhiana

€SERTIFICATE

We hereby certify that the informed patient consent form and its translation and back translation to Hindi and Punjabi are accurate to the best of our knowledge and satisfaction.

Supervisor

DR. PANKAJ MAHINDRA
Associate Professor
Department of Orthopaedics
DMC&H, Ludhiana

Co-supervisor

DR. RAJNISH GARG
Professor and head
Department of Orthopaedics
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DR.PARMINDER SINGH
Professor and Head
Department of Endocrinology
DMC&H, Ludhiana

Dr. Aarna Athwal
PG Resident,
Department of Orthopaedics,
DMC&FJ, Ludhiana,

CONSENT FORM

Dated: _____

I, _____ S/o,D/o,W/o _____

R/o _____

hereby willingly give consent to participate in the study **'Evaluation of bone mineral density score in patients undergoing Total knee replacement'** being conducted by Dr. AamnaAthwal PG Resident in the Department of Orthopedics, Dayanand Medical College and Hospital, Ludhiana.

I have been explained the procedure, advantages and all possible complications of the involved study procedure in the language I fully understand. I affirm that there has been no compulsion or monetary inducement in my agreeing to be a volunteer for this study. I also understand that the study is for the purpose of medical research and I am willing to extend my full c‹›operation towards the same after full comprehension and on my own free will. I therefore, give the consent of being interviewed, examined, and investigated and being part of this interventional study.

I can opt out of the study at any time. This will not affect my treatment.

_____ _____

Patient Signature Witness Signature

_____

Candidate Signature

मरीज अनुमति फार्म

तिथि .....

मैं ..... पत्नी/पुत्र/पुत्री .....

निवासी .....

इस शोधकार्य "Evaluation of bone mineral density score in patients undergoing Total knee replacement" में भाग लेने के लिए सहमत हूँ। मैं इस शोधकार्य में भाग लेने के लिए अपनी स्वेच्छा से तैयार हूँ। मैं पुष्टि करता/करती हूँ कि यह स्वीकृति देने के लिए मुझे कोई आर्थिक प्रलोभन नहीं दिया गया है और न ही दबाव डाला गया है। मुझे इस शोधकार्य का उद्देश्य स्पष्ट कर दिया गया है और मुझे यह विश्वास है कि यह विज्ञान और मानवता के लाभ के लिए है। मुझे इस शोधकार्य में होने वाले जोखिम के बारे में समझा दिया गया है और मेरी समझ में यह जोखिम बहुत मामूली है।

मैं इस शोधकार्य में भाग लेने के सम्बन्ध में किसी भी समय अपनी अस्वीकृति व्यक्त कर सकता/सकती हूँ और मेरे अस्वीकृति व्यक्त करने का मेरे इलाज पर कोई प्रभाव नहीं पड़ेगा।

.....	.....
गवाह के हस्ताक्षर	**रोगी के हस्ताक्षर/अंगूठे का निशान**
नामः	**नामः**

.....

अन्वेषक के हस्ताक्षर

.....

विद्यार्थी के हस्ताक्षर

ਮਰੀਜ਼ ਰਜ਼ਾਮੰਦੀ ਫਾਰਮ

ਮਿਤੀ_____

ਮੈ_____ਪਤਨੀ/ਪੁੱਤਰ/ਪੁੱਤਰੀ_____

ਵਾਸੀ _____

Evaluation of bone mineral density score in patients undergoing total knee replacement ਤੇ ਚਲ ਰਹੀ ਖੋਜ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਲਈ ਰਜ਼ਾਮੰਦ ਹਾਂ। ਇਸ ਖੋਜ ਕੰਮ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਲਈ ਮੈ ਆਪਣੀ ਮਰਜ਼ੀ ਨਾਲ ਤਿਆਰ ਹਾਂ। ਮੈ ਇਹ ਦਸਣਾ ਚਾਹੁੰਦਾ ਹਾਂ/ ਚਾਹੁੰਦੀ ਹਾਂ ਕੇ ਇਹ ਰਜ਼ਾਮੰਦੀ ਦੇਣ ਵਾਸਤੇ ਮੈਨੂ ਕਿਸੇ ਵੀ ਤਰਾਂ ਦਾ ਲੋਭ-ਲਾਲਚ ਨਹੀ ਦਿੱਤਾ ਗਿਆ ਅਤੇ ਨਾ ਹੀ ਕੋਈ ਦਬਾ ਪਾਇਆ ਗਿਆ ਹੈ। ਮੈਨੂ ਇਸ ਖੋਜ ਦਾ ਮਨੋਰਥ ਸਮਝਾ ਦਿੱਤਾ ਗਿਆ ਹੈ ਅਤੇ ਮੈਨੂ ਇਹ ਭਰੋਸਾ ਦਵਾਇਆ ਗਿਆ ਹੈ ਕੇ ਇਹ ਖੋਜ ਵਿਗਿਆਨ ਅਤੇ ਮਾਨਵਤਾ ਦੀ ਭਲਾਈ ਲਈ ਹੈ। ਮੈਨੂ ਇਸ ਖੋਜ ਵਿਚ ਹੋਣ ਵਾਲੇ ਖਤਰੇ ਬਾਰੇ ਸਮਝਾ ਦਿੱਤਾ ਗਿਆ ਹੈ ਅਤੇ ਮੈਨੂ ਇਹ ਯਕੀਨ ਹੈ ਕੇ ਇਹ ਖਤਰਾ ਬਹੁਤ ਮਾਮੂਲੀ ਹੈ। ਮੈਨੂ ਇਸ ਖੋਜ ਕੰਮ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਦਾ ਢੰਗ – ਤਰੀਕਾ ਸਮਝਾ ਦਿੱਤਾ ਗਿਆ ਹੈ।

ਮੈ ਇਸ ਖੋਜ ਕੰਮ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਬਾਰੇ ਆਪਣੀ ਰਜ਼ਾਮੰਦੀ ਕਿਸੇ ਵੀ ਸਮੇ ਵਾਪਸ ਲੈ ਸਕਦਾ ਹਾਂ/ ਸਕਦੀ ਹਾਂ ਅਤੇ ਮੇਰੀ ਰਜ਼ਾਮੰਦੀ ਵਾਪਸ ਲੈਣ ਦਾ ਮੇਰੇ ਇਲਾਜ ਤੇ ਕੋਈ ਅਸਰ ਨਹੀ ਹੋਵੇਗਾ।

_____
ਗਵਾਹ ਦੇ ਹਸਤਾਖਰ

ਮਿਤੀ_____

ਪਤਾ _____

_____
ਨਿਰੀਖਕ ਦੇ ਹਸਤਾਖਰ

_____
ਸਿਖਿਆਰਥੀ ਦੇ ਹਸਤਾਖਰ

_____
ਮਰੀਜ਼ ਦੇ ਹਸਤਾਖਰ

ਮਿਤੀ_____

ਪਤਾ _____